PUBLIC DOCUMENT, No. 4

TWELFTH ANNUAL REPORT

OF THE

NORTH DAKOTA

Agricultural Experiment Station

AGRICULTURAL COLLEGE, N. D.,

TO THE

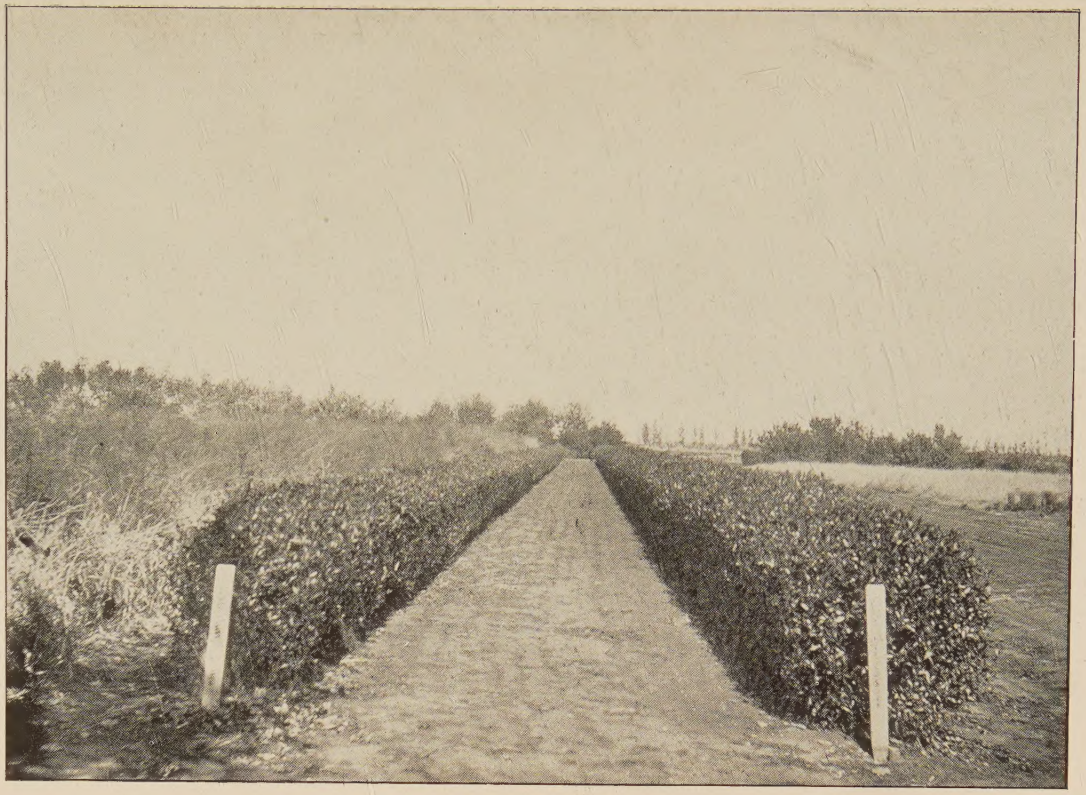
GOVERNOR OF NORTH DAKOTA

February 1, 1902.

BISMARCK TRIBUNE
STATE PRINTERS AND BINDERS
1902

TYPICAL PLUM TREE, FIVE YEARS OLD, IN BUD (Station Grounds).

SHELTER HEDGE OF GOLDEN RUSSIAN WILLOW, FIVE YEARS OLD (Station Grounds).



HEDGES OF GOLDEN RUSSIAN WILLOW, THREE YEARS OLD, TRIMMED LOW FOR ORNAMENTAL PURPOSES.

FOUR-YEAR-OLD TREE OF CAROLINA POPLAR. RETAINS ITS FOLIAGE LONG AFTER

HEDGES OF GOLDEN RUSSIAN WILLOW, CARAGANA, AND BUFFALO BERRY—NAMED FROM RIGHT TO LEFT (Station Grounds).

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STATION STAFF.

J. H. Worst, LL. D. ..... Director
E. F. Ladd, B. S. ..... Chemist
C. B. Waldron, B. S. ..... Horticulturist
H. L. Bolley, M. S. ..... Botanist
J. H. Shepperd, M. S. A. ..... Agriculturist
A. M. Ten Eyck, M. S. ..... Assistant Agriculturist
T. R. Manns, B. S. ..... Assistant Botanist
L. B. Green, B. S. ..... Assistant Chemist
R. S. Northrop, B. S. ..... Assistant Horticulturist
H. M. Ash ..... Foreman in Agricultural Department
C. A. Baldwin ..... Foreman in Horticultural Department
Herman Croft ..... Herdsman
J. Jessen ..... Assistant Herdsman
C. E. Nugent ..... Secretary

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LETTER OF TRANSMITTAL.

Agricultural College, N. D., February 1, 1902.

To His Excellency, Frank White, Governor of the State of North Dakota:

Sir: As required by act of congress approved March 2nd, 1887, and section 945, Revised Codes of 1899, I hereby submit the twelfth annual report of the North Dakota Experiment Station, for the year ending February 1st, 1902, together with a financial statement of receipts and disbursements as required by law, for the government fiscal year ending June 30th, 1901.

Very respectfully yours,

W. H. ROBINSON,
President Board of Trustees.

REPORT.

To the Board of Trustees of the North Dokota Agricultural College and Experiment Station:

Gentlemen: I have the honor to submit to you the Twelfth Annual Report of the North Dakota Agricultural College and Experiment Station. The past season has been satisfactory for doing experimental work, but on account of insufficient drainage and excessive rainfall during the early part of July, a portion of the experimental farm was flooded with water, which resulted in considerable damage.

The experiments in agriculture were confined largely to crop rotation, conservation of moisture, seed breeding and seed selection, cultivation methods, etc. The experiments in horticulture were devoted to the growing of small fruits, berries, vegetables, planting trees, hedges, etc.

The following bulletins were published during the year:

No. 47 Humus and soil nitrogen.
Climatic studies with wheat, oats and corn.
Brome and timothy compared.
Austrian Brome hay.

No. 48. Wheat farming experiments and soil moisture studies.
(1) The wheat crop of 1900 grown under different methods of farming.
(2) A study of the conservation of soil moisture:
(a) By cultivation.
(b) By crop rotation.
(c) By different methods of summer fallowing.
(d) By manuring.
(3) A study of the effect of the winter season upon the moisture content of the soil.
(4) Weather and crop records for 1898, 1899 and 1900.

No. 49. Some points on fruit culture.

No. 50. Flax wilt and some minor problems affecting flax growing.

During the past year two frame barns were built in place of the combination horse and cow barn that was burned January 4, 1901. The new horse barn is a two-story structure and contains 18,180 feet of floor space. It contains a class room with seating capacity for one hundred twenty-five students, and is used for classes in stock judging, stock scoring, veterinary clinics, etc. The barn is built of the best material, and is very

attractive in appearance, and convenient in its general arrangements.

The cow barn is also frame, two stories, attractive in design and convenient in all its arrangements, with 14,330 feet floor space, and has connected with it a two hundred ton brick silo.

A very complete sewerage system has been constructed, connecting all the station buildings with the Ninth avenue trunk sewer, (city), which will enable us to materially improve the barn yards and adjacent grounds. The two barns were built at an expense of $17,900, and the sewerage system cost $5,300.

Since my last report farmers institutes were held at Buxton, Finley, Grafton, Valley City, Wahpeton, Crystal, Thompson, Drayton, Oakes, Cogswell, Edgeley, Lisbon, Kenmare, Minot, Fessenden, St. Thomas, Langdon, Park River, Larimore, Michigan City, Rugby, Bottineau and Cando. At eleven of these institutes, members of the station staff took complete or partial charge of the lecture work, and the regular institute corps, consisting of T. A. Hoverstad, of the Minnesota sub-Experiment Station at Crookston, Hon. L. A. Ueland of Edgeley, and E. G. Schollander, conducted the others.

Col. Wilkinson, of the Great Northern Railway Company, rendered valuable assistance in the northern counties.

The demand for farmers institutes more than keeps pace with the funds appropriated for that purpose. At least $5,000 per year should be made available by the legislative assembly for farmers institutes, and at least one farmers club or agricultural society should be organized in each county with assurance of an institute conducted at state expense, once a year. Many farmers of every community are well qualified to take a leading part in the discussions incident to a farmers institute, and where a permanent organization is maintained, as above indicated, several institutes of a local character can be held annually without material expense to the organization, and with much profit to the farming community.

A very marked improvement in agricultural methods, crop rotation, diversified farming, seed selection, is already observable throughout the state, and much of this improvement came so unconsciously that the farmers themselves have scarcely realized the extent of the progress they have made, or the cause. Many problems of great importance to our agricultural interests yet await solution, not the least of which is the movement of moisture in the soil.

The reports made to me by the heads of the different departments are of unusual interest, and convey much valuable information for the farmers of the state, all of which I respectfully submit.

J. H. WORST,
Director.

CHEMICAL DEPARTMENT.

To J. H. Worst, Director:

Sir: The present is the twelfth annual report submitted by the writer for the chemical department, and covers briefly the chemical work done in the Experiment Station for the year 1901.

There has been a large increase, during the past year, in both analytical and investigational work required of the chemical department. This work represents demands pretty generally from all parts of the state. The amount of correspondence has nearly if not quite doubled during the past year. Frequently, the questions asked have called for a considerable amount of time in compiling data, or work in making experiments that would enable us to intelligently reply to the questions.

During the past year two lines of co-operative work have been carried on in connection with the department of agriculture at Washington. One of these lines of investigation is for the purpose of determining the amount of water necessary to produce a given amount of plant growth in relation to the available plant food present in the soil. It is expected this investigation will be continued for another year. Co-operative work in sugar beet experiments with the farmers of the state was also undertaken by this department; and seed furnished to nearly 1,600 farmers in the state. This necessitated the making of several hundred analyses of beets during the past fall, the results of which will be published as a bulletin at a later date.

SUMMARIES OF TEMPERATURE, RAINFALL AND SUNSHINE.

The record for previous years will be found in preceding reports, and below we give the maxima, minima, and mean monthly temperatures for the year 1901:

TEMPERATURES AND RAINFALL, 1901.

Months	Means	Maximas	Minimas	Rainfall inches
January	6.4	24	—20	.05
February	6.2	44	—21	.11
March	8.2	51	—9	1.31
April	45.5	85	23	1.76
May	5.9	94	30	.98
June	63.2	90	30	5.91
July	71.4	96	48	7.29
August	67.4	97	39	1.59
September	54.8	92	23	2.57
October	47.4	81	23	3.83
November	25.0	57	2	.00
December	Lost	36	—38	.28
				25.68

The rainfall for the year has been 5.90 inches above the average for ten years preceding, and .14 of an inch more than in 1900, which was a year of exceptional rainfall.

By years we give below the rainfall as recorded at this station beginning with 1892:

	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901
Rainfall inches	20.73	16.17	18.72	16.85	20.33	22.30	16.20	21.20	25.54	25.68

This gives an average annual rainfall of 20.37 inches for the period 1892 to 1901 inclusive; a minimum of 16.17; and a maximum of 25.68 inhcse

MONTHLY RECORD OF SUNSHINE.

The hours of actual sunshine, as given in the following table, are those as recorded by a Friez photographic sunshine recorder. No correction has been made for early morning and evening sunshine unrecorded. Probably about 12 to 15 per cent should be added to the results as given by the instrument:

SUNSHINE—1901.

Months	Total Hours		Hours—Daily Mean		Percentage of Possible Sunshine
	Possible	Recorded	Possible	Recorded	
January	279.0	111.9	9.00	3.60	40.00
February	287.1	143.9	10.40	5.14	50.20
March	369.0	180.9	11.90	5.83	48.90
April	407.3	175.2	13.58	5.84	42.70
May	466.3	298.1	15.00	9.61	64.80
June	475.0	192.0	15.80	6.40	40.40
July	480.2	257.5	15.46	8.30	53.50
August	441.8	248.0	14.23	8.27	57.90
September	378.3	211.5	12.60	7.05	55.80
October	337.5	195.0	10.89	6.29	57.70
November	281.6	119.8	9.38	3.99	42.80
December	267.1	69.9	8.60	2.26	26.30
Total and means	4470.2	2203.7	12.24	6.05	49.43

The total hours of recorded sunshine and percentages of possible sunshine for the three years have been as follows:

	1899	1900	1901
Total hours recorded	2166.85	2116.5	2203.7
Daily mean hours recorded	5.97	5.7	6.05
Percentage of sunshine	48.8	47.1	49.43

This shows a slightly higher percentage of sunshine for the past year than for the two preceding years.

BROME GRASS VS. TIMOTHY.

The results of experiments made with brome grass as compared with timothy for 1900 have already been published. (Bulletin No. 47, North Dakota Agricultural College, pp. 711-721.) In these experiments the superior quality of brome grass over timothy for a dry season was clearly shown. In order to find what the results would be in an average year, examination of the grasses from the plots were made during the past season. The results for brome grass are shown in the following:

	Date Cut				
	May 24	June 26	July 17	Aug. 16	Sept. 26
Height, inches	10.00	8.00	9.00	4.5	.....
Yield per acre	5536.00	2496.00	2272.00	960.00	480.00
Dry matter per acre	1439.40	570.00	516.90	249.60	194.10

ANALYSIS OF BROME GRASS (PASTURE.)

	May 24	June 26	July 17	Aug. 16	Sept. 26
Water	74.00	77.16	77.25	74.00	59.56
Ash	2.33	2.55	2.69	3.05	4.70
Fat	1.65	1.39	1.55	1.87	2.80
Protein NX 6.25	6.19	3.23	3.08	4.92	6.49
Crude fiber	4.01	6.41	6.08	6.65	9.92
Nitrogen—free extract	11.84	9.25	9.43	9.52	16.52
Totals	100.00	100.00	100.00	100.00	100.00

ANALYSIS FOR ABOVE (WATER FREE).

Ash	8.96	11.17	11.85	11.74	11.61
Fat	6.28	6.08	6.83	7.21	6.92
Protein NX 6.25	15.44	14.16	13.56	18.94	16.06
Crude fiber	23.79	28.08	26.38	25.58	24.54
Nitrogen—free extract	45.54	40.52	41.38	36.55	40.85
Totals	100.00	100.00	100.00	100.00	100.00

The yields per acre for the season, expressed in pounds, of the several constituents were as given below:

	May 24	June 26	July 17	Aug. 16	Sept. 26	Totals
Ash	128.9	63.60	61.3	29.3	22.6	305.70
Fat	90.4	34.60	35.3	1.8	13.4	191.70
Protein NX 6.25	222.2	80.77	70.1	47.2	31.2	451.47
Fiber	342.4	159.90	136.3	63.9	47.6	750.10
Nitrogen—Free extract	655.5	230.90	213.9	91.2	79.3	1270.80
Totals	1439.4	569.77	516.9	249.6	194.1	2469.77

TIMOTHY GRASS (PASTURE).

Two cuttings only were made of timothy, these corresponding to the first two for brome grass, May 27 and June 26. The heavy rains after this date completely drowned out the timothy, so that no further growth for the season was made. Brome grass in 1900 demonstrated its superior value to timothy in times of prolonged drought; and, again, in 1901, the results indicate that brome grass is superior to timothy in very wet land, or seasons of extreme rainfall.

The results of the two cuttings of timothy (pasture) are given below:

	Date Cut	
	May 27	June 26
Height, inches	8.5	9.0
Yield per acre, pounds	2560.0	1600.0
Pounds dry matter per acre	851.2	448.3

ANALYSIS OF TIMOTHY GRASS (PASTURE).

	May 27	June 28
Water	66.75	71.98
Ash	2.56	2.54
Fat	2.10	1.44
Protein NX 6.25	3.40	3.10
Crude fiber	7.80	7.46
Nitrogen—Free extract	17.39	13.48
	100.00	100.00

The analysis of the water free substance is indicated in the accompanying table together with the yield per acre:

	May 27		June 26	
	Per cent	Pounds per acre	Per Cent	Pounds per acre
Ash	7.71	65.6	9.07	40.7
Fat	6.31	53.7	5.14	23.0
Protein NX 6.25	10.22	87.0	11.06	49.6
Crude fiber	23.45	199.6	26.61	119.3
Nitrogen—free extract	52.31	445.3	41.38	215.7
	100.00	851.2	100.00	448.3

Comparing the brome grass yield for the season with that of timothy and we have expressed in pounds:

	Brome	Timothy
Total yield (green)	12244.0	4160.0
Dry matter	2970.0	1299.5
Ash	305.7	106.3
Fat	191.7	76.7
Protein NX 6.25	451.5	136.6
Fiber	750.1	318.9
Nitrogen—free extract	1270.8	661.0
	2969.8	1299.5

The brome grass yielded for the season 8084 pounds more of green feed than did the timothy; or, a difference in favor of the brome grass for pasturage much more marked than was the case for 1900, the season of prolonged drought.

BROME GRASS HAY.

Brome grass (bromus inermis), was cut for hay at two stages of development. The dates were July 8 and 17. On the first date the grass was not all headed out, about two-sevenths being as yet unheaded, the balance just in head. The average height of that not headed was about 26 inches; while the grass in head averaged about 36 inches in height. On July 17, the grass as cut was in the brown state of head, while the first cutting was in the purple. The fully headed grass, July 17, averaged about 38 inches high, while that not so far advanced averaged about 28 inches in height.

	Date Cut	
	July 8	July 17
Height, inches	26.36	28.38
Yield per acre	9440.00 pounds	12032.00 pounds
Dry matter per acre	3445.50	4314.70 pounds

This shows a gain of 919 pounds per acre of dry matter from July 8 to the 17th.

The analysis of the two lots of hay are shown below.

	Fresh Substance		Dry Substance	
	July 8	July 17	July 8	July 17
Water	64.56	64.14		
Ash	2.95	3.02	8.35	8.43
Fat	1.58	1.76	4.48	4.91
Protein NX 6.25	3.10	3.97	8.75	11.08
Crude fiber	10.47	10.90	29.58	30.40
Nitrogen—Free extract,	17.34	16.21	48.84	45.18
	100.00	100.00	100.00	100.00

The two samples above for 1901 do not show as high protein content as was found in the hay for 1900. The two seasons, however, were very unlike and the crop results were modified by these conditions.

Calculating the yields per acre for the several constituents, we have as follows:

	July 8— Pounds	July 17— Pounds
Ash	2.79	363.7
Fat	149.9	211.8
Protein NX 6.25	292.7	478.1
Fiber	989.0	1311.7
Nitrogen—Free extract	1633.2	1949.4
	3344.00	4314.7

These results come as a continuation of the experiments in 1901 of those undertaken in 1900 and already published. The results are all indicative of the high value of brome grass for both pasture and hay crop in North Dakota.

For the benefit of those who may not have Bulletin No. 47, issued by this department, I repeat the conclusions there presented regarding Brome grass:

CONCLUSIONS.

1. "Brome grass produced a fair amount of pasturage in the dry year of 1900 while timothy made very little growth.
2. "Animals prefer brome pasture to timothy as shown in their grazing for 1899, when there was an abundance of both grasses, and in 1900 we have like results.
3. "There was but little difference in chemical composition between pasture grass from brome and from timothy. The total yield per acre was much in favor of the brome grass.
4. "Brome grass made a fair crop of hay in 1900, while timothy failed.
5. "Brome hay contains about twice as much protein as timothy.
6. "Brome hay does not contain more fiber than the average for timothy grown in all parts of the United States.
7. "Brome grass sends its roots down deeper into the soil than timothy and furnishes a great mass of roots in the first foot of soil and hence the soil may be expected to blow less when plowed.
8. "Soils on which brome grass has been grown contain more organic matter and humus than those on which timothy has been grown.
9. "Brome grass is a better humus former than timothy and leaves the soil in better chemical and physical condition than does the timothy."

The conclusions above for 1900 are fully born out in 1901. In addition brome grass has demonstrated that in wet years, as well as in dry seasons, it is superior to timothy as a pasture or as a hay producer on the college grounds.

BROME HAY.

ASH ANALYSIS.

A sample of brome hay cut on the college farm July 9, 1900, contained 7.29 per cent of ash.

An analysis of the ash gave results as follows:

	Per Cent
Carbon	5.71
Sulfuric acid SO_3	5.77
Silica and sand	33.52
Potash K_2O	28.08
Soda Na_2O	2.34
Phosphoric acid P_2O_5	9.84
Iron Fe_2O_3 / Alumina Al_2O_3	2.58
Magnesia MgO	6.20
Calcium CaO	6.12
	100.16

ASH ANALYSIS OF WHEAT.

A sample of Fife wheat grown in the Red River valley, containing 2.26 per cent of ash, was analyzed with results as below:

	Per Cent
Carbon	Trace
Sand and silica	2.74
Iron Fe_2O_3 / Alumina Al_2O_3	1.00
Lime CaO	7.32
Magnesia MgO	8.91
Sulfuric acid SO_3	1.49
Phosphoric acid P_2O_5	48.84
Potash K_2O	18.51
Soda Na_2O	12.02
	100.81

FLOUR FROM ARNAUTKA WHEAT.

Considerable interest is manifested in the macaroni wheats and the flours produced from this class of wheats. Mr. F. R. Strong, of Scoville, N. D., sent to the laboratory a sample of flour produced from one of these wheats—the variety known as Arnautka wheat. This wheat he has been growing upon his farm since 1893, so that it has become thoroughly acclimated.

An examination was then made to determine the composition analysis is given below:

	Per Cent
Water	5.02
Ash	.85
Proteids, NX 6.25	15.69
Fat	2.16
Crude fiber	.74
Nitrogen--Free extract	75.54
	100.00
Total nitrogen	2.51

The results show this sample of flour to contain considerable more of proteids than are found in the average of our hard wheat flours.

An examination was there made to determine the composition of the proteids and the results are given as follows:

	Nitrogen	Proteids
Water soluble	.35	2.19
Salt soluble	.16	1.00
Gliadin	1.17	7.31
Glutinin	.75	4.69
	2.43	15.19
Loss	.08	.50

The total gluten, then, in this sample of flour, amounted to 12 per cent, which is about 20 per cent higher than that for average hard wheat flours. The gluten constituted 77 per cent of the total proteids, and the gliadin was about 61 per cent of the total gluten.

It is generally considered that the gluten of flour should constitute not less than 80 per cent of the total proteids, and that the gliadin should constitute from 60 to 65 per cent of the gluten.

Judged from the chemical analysis, the flour would be considered of excellent quality. In physical appearance, the flour seems somewhat harsher to the touch than the average flours, and in color it is much more creamy.

INFANT FOODS.

During the past year the following "Infant Foods" have been analyzed with results as shown in the accompanying table:

	Mellin's	Nestle's	Horlick's
Water	2.73	7.68	1.47
Ash	4.54	1.29	3.11
Proteids	9.56	9.31	14.13
Fat (ether extract)	.60	4.39	1.97
Starch and dextrine	31.05	38.31	30.92
Glucose	20.40	4.02	20.40
Sucrose	31.12	34.80	28.00
	100.00	100.00	100.00

An analysis was also made of a sample of Horlick's Tablets; but in this case no separation of the carbohydrates was made:

Water	2.85
Ash	3.43
Proteids	15.43
Fat (Ether Extract)	2.45
Carbohydrates	75.84
	100.00

PLASMON.

A new series of food products, in the form of a dry powder, known as plasmon, has been generally advertised. Several of these preparations are on the market, three of which we have examined. These are plasmon powder, plasmon biscuit, and plasmon chocolate:

ANALYSIS OF DRY SUBSTANCE.

	Plasmon	Plasmon Biscuit
Ash	7.72	1.78
Proteids	70.15	19.68
Fat	.28	10.02
Carbohydrates	21.84	68.52
	100.00	100.00

An analysis of the plasmon chocolate showed it to contain 21.10 per cent of proteids.

The manufacturers assert in their circulars "that one teaspoon-

ful of plasmon contains all the actual nutriment in one-quarter pound of the best beef."

They state further in regard to the biscuit that, "six of these biscuits contain the actual nutrition found in one-quarter pound of the best tenderloin of beef. This is a fact which has been proven by both chemical and physiological tests."

The average weight of the biscuits, for example, was 4.8069 grams; or, the weight of six biscuits would equal 28.8414 grams. These biscuits were found to contain 19.68 per cent of proteids; or, in one-fourth pound there would be 18.05 grams proteids; or, more than three times as much proteids are found in six of the plasmon biscuits.

That plasmon is a valuable food product need not be questioned; but misleading statements are not to the credit of the manufacturers.

BOILER SCALE.

Two samples of boiler scale have been analyzed, and as the results are of value in showing the composition of these products, we give the analysis below:

	Sample No. 1	Sample No. 2
Moisture	1.62	0.80
Silica SiO_2	7.87	32.83
Sulfuric acid SO_3	Trace	22.02
Phosphoric acid P_2O_5	.21	0.23
Carbon dioxide CO_2	16.16	1.85
Lime CaO	48.27	26.76
Magnesia MgO	8.11	6.90
Iron Fe_2O_3 / Alumina Al_2O_3	1.43	3.20
Alkalies	Trace	Trace
Volatile matter	16.30	5.41
	100.00	100.00

SOILS OF NORTH DAKOTA.

During the past twelve years a considerable number of soils, representing nearly all sections of the state, have been examined. Many of these samples represented typical soils from the several localities; and I have thought it advisable to compile the data for these analyses, heretofore published, where the samples appear to be representative of any considerable areas. I will first present the results of the physical examination of these soils so far as made.

PER CENT OF SOIL THAT PASSED THROUGH SIEVE WITH NUMBER OF MESHES PER SQUARE INCH IN SIEVE.

Soils From	No. Examined	Meshes or Openings Per Square Inch					
		100	80	60	40	20	10
Red river valley	8	41	47	57	72	93	99
James river valley	6	58	65	78	91	98	100
Sheyenne river valley	2	2	43	60	78	91	95
Devils Lake region	6	6	33	42	58	72	92
Turtle mountain region	5	5	47	56	67	88	97
Wells county	1	1	66	78	91	97	99
West of Missouri	2	2	34	56	74	88	92
Mouse river valley	1	1	82	90	98	98	100
South counties (east)	5	5	54	61	79	92	99
Means	...	46	52	62	79	91	97

Analysis of Soils from Different Localities Within the State.

	Red River Valley (21 Samples)	James River Valley (5 Samples)	Sheyenne River Valley (2 Samples)	Mouse River Valley (4 Samples)	Devils Lake Region (10 Samples)	Turtle Mountains (8 Samples)	Wells County (2 Samples)	South Counties (7 Samples)	West Missouri (2 Samples)
Insoluble silica.....	59.00	65.53	55.73	65.53	66.59	74.79	79.05	66.97	73.37
Combined silica.....	8.15	10.40	8.38	9.34	5.04	5.30	6.03	10.72	5.60
Lime CaO	4.16	1.07	14.67	2.19	6.08	.77	.41	.96	.32
Magnesia MgO.....	.81	.57	.93	.51	.61	.47	.28	.14	.43
Phosphoric acid P_2O_5..	.19	.27	.17	.18	.12	.14	.19	.25	.19
Sulfuric acid SO_3.....	.17	.03	.77	.35	.04	.06	.06	.16	.04
Iron Fe_2O_3.....	3.69	3.09	2.44	2.78	2.38	2.73	2.90	3.36	1.68
Alumina Al_2O_3.....	3.11	3.44	2.43	5.20	2.19	2.79	2.01	2.99	3.79
Potash K_2O.....	.54	.48	.54	.34	.57	.55	.45	.45	.35
Soda Na_2O.....	.73	.66	1.24	.88	1.12	.58	.63	.29	.49
Volatile matter.....	19.30	14.13	13.61	11.85	13.23	12.16	8.00	13.69	13.50
	99.85	99.67	100.81	100.15	98.97	100.34	100.01	99.99	99.76

The results for many analyses of soils are not included in the above, since the samples in some cases were selected to determine specific points and the soils did not represent extended areas; and, in other cases, the history of the soil sample is not known well enough to justify its use in this case. The analysis of the sixty-five samples reported upon above, however, furnish data for judging of the soils of the state and clearly show all the soils to be naturally well supplied with the elements of fertility.

ANALYSIS OF SUB-SOILS.

A few samples of sub-soil representing the several sections of the state, have been analyzed. The results of the analyses may be of interest to our readers, and will show what the character of the material is, upon which our surface soil rests.

The following indicates by number the section of the state from which the sample was taken:

100 Red River Valley.
101 James River Valley.
102 Sheyenne River Valley.
103 Devils Lake Region.
104 Turtle Mountain Region.
105 West of Missouri.
106 South Counties (East of Missouri River).

ANALYSIS OF SUBSOILS FROM THE COLLEGE.

	100	101	102	103	104	105	106
Insoluble silica	62.03	69.51	49.08	54.88	54.37	65.73	85.20
Combined silica	7.11	8.18	8.18	11.63	9.03	17.03	
Lime CaO	6.23	3.53	18.26	4.26	13.95	trace	.55
Magnesia MgO	1.49	.88	1.68	1.21	1.48	.63	.21
Phosphoric acid P_2O_5	.23	.13	.17	.19	.14	.17	.29
Sulfuric acid SO_3	.04	trace	4.41	.20	1.09	.12	1.06
Iron Fe_2O_3	4.84	3.81	2.30	1.52	4.14	1.00	2.24
Alumina Al_2O_3	4.77	3.46	1.86	3.65	3.07	3.63	2.73
Potash K_2O	.43	.55	.49	.43	.68	.51	.68
Soda NaO_2	1.14	.98	1.55	.58	.84	.24	.27
Undetermined and Volatile matter	11.62	9.07	10.92	21.45	11.21	11.04	7.38
	100.00	100.00	100.00	100.00	100.00	100.00	101.56

As further showing the character of the soils and subsoils, samples from the station experiment plats were taken at different depths and submitted to analysis. These samples represent the soils taken at a depth of 1 to 6 inches, 6 to 12 inches, two feet, three feet and four feet.

The result of the analysis is shown in the following table:

SOIL FROM STATION PLANTS.

	1 to 6 in.	6 to 12 in.	2 feet	3 feet	4 feet
Insoluble silica	64.07	59.51	52.09	43.83	34.83
Combined silica	3.53	9.86	15.18	17.43	23.78
Lime CaO	1.47	1.46	2.75	6.55	8.34
Magnesia MgO	.72	.42	1.23	.97	.45
Phosphoric acid R_2O_5	.21	.20	.19	.16	.15
Sulfuric acid SO_3	.31	.13	.25	.12	.25
Iron Fe_2O_3	4.32	4.26	5.20	4.40	4.14
Alumina Al_2O_3	5.67	7.39	7.28	7.29	8.68
Potash K_2O	.77	.63	.54	.63	.54
Soda Na_2O	.31	.40	.40	.33	.51
Volatile matter	16.62	12.45	11.88	14.49	15.35
Moisture	2.30	2.55	2.66	2.56	2.55
	100.30	99.26	99.65	98.76	99.55
Nitrogen	.37	.24	.075	.05	.016

These results show the soil to contain a good supply of the essential elements of fertility: phosphoric acid, potash, lime, etc. Even at a depth of four feet, there is 0.15 per cent of phosphoric acid and 0.54 per cent of potash.

SOIL FROM THE SUB-STATION AT EDGELEY, N. D.

A sample of soil representing the first foot, and another representing the second foot, or the sub-soil, from the experimental field on the Edgeley State Sub-Station, was analyzed with results as follows:

	Per Cent, First Foot	Per Cent, Second Foot
Silicates	82.45	85.10
Lime CaO	.65	.55
Magnesia MgO	.23	.20
Phosphoric acid P_2O_5	.20	.29
Sulfuric acid SO_3	.74	1.03
Iron Fe_2O_3	2.25	2.34
Alumina Al_2O_3	2.51	2.61
Potash K_2O	.61	.72
Soda Na_2O,	.57	.26
Volatile matter	9.70	6.95
	99.91	100.05
Humus	2.36	1.30
Nitrogen	0.26	0.10

From the above it will be observed, that while this soil is well supplied with mineral plant food, it is deficient in organic mat-

ter, and in humus content. It is believed that the chemical conditions of this soil could be much improved by a good system of crop rotation.

SOILS FROM STATION PLATS.

Soils from four of the rotation plats on the station grounds have been analyzed, and the results are of interest as showing the chemical condition of these soils at the end of ten years' continuous wheat cropping since the college began the experiments. The same land had been in continuous wheat, so far as known, since 1883.

	Soil 1 to 10 inches				Bottom of second root	
	Plat 1	Plat 2	Plat 24	Plat 25	Plat 2	Plat 25
Insoluble silica..... } Combined silica..... }	70.15	70.57	70.71	72.26	68.53	64.24
Lime CaO	1.08	1.39	1.07	1.19	.97	2.80
Magnesia MgO.....	.34	.50	.44	.68	.32	.51
Phosphoric acid P_2O_5.	.27	.29	.38	.39	.24	.33
Sulfuric acid SO_3.....	.15	.14	.21	.18	.15	.13
Iron Fe_2O_3	5.10	4.87	4.33	4.66	5.55	5.62
Alumina Al_2O_3	6.29	6.82	5.49	6.09	7.36	7.63
Potash K_2O.....	.79	.82	.78	.96	.57	.59
Soda Na_2O	.40	.59	.58	.56	.17	.16
Volatile matter.....	14.95	14.81	13.45	12.90	7.80	9.89
Moisture.....	10.77	10.17	11.23	10.61	9.00	8.38
	100.29	100.96	99.67	100.48	100.68	100.58
Nitrogen	.....	.36	.....	.....	.13	.....

The results given in the preceding table indicate that, the soil in the series of plats used in crop rotation has similar composition for the two ends of the field.

An analysis of the soil, taken to the depth of ten inches, from the same field, in 1891, gave results at that time as follows:

	Per Cent
Total silicates.....	69.11
Lime CaO.....	.88
Magnesia MgO.....	.51
Phosphoric acid P_2O_3.....	.23
Sulfuric acid SO_3.....	.14
Iron Fe_2O_3.....	4.59
Alumina Al_2O_3.....	2.61
Potash K_2O	.57
Soda Na_2O.....	.58
Volatile matter.....	20.98
	100.20

In 1891, when the first sample was taken, the field had not been laid out in plats; and the sample represented not any single plat, but portions taken at several points over the field.

SOIL INVESTIGATIONS.

A large amount of analytical work has been done in connection with a study of soils, especially along the line of determining nitrates, humus, and the relation of humus to mineral constituents of the soil, available for plant food. This data is reserved for a future bulletin.

Bulletin 47, published by this department during the past year, contains the result of work done for the preceding year on "Humus and Soil Nitrogen." I repeat here the conclusions that were given at the close of that bulletin.

CONCLUSIONS:

1. "If you would keep the soils in the best chemical and physical condition, there must be practiced such a system of rotation that there shall be included in the rotation humus producing and humus consuming crops.

2. "Two humus producing, to three humus consuming crops should, with proper cultivation, maintain the soil in its highest state of productivity.

3. "Soils fertile by nature, such as the Red River Valley soil, should, under a system of agriculture, as indicated above, yield goods crops, without the aid of commercial fertilizers for a thousand years. This assumes the proper use of all barn manures and the prevention of unnecessary loss from the soil.

4. "A proper system of crop rotation should result in enriching the surface soil with plant food rather than in depleting it, and especially should this be true for nitrogen and humus.

5. "The first foot of soil in the Red River Valley contains enough plant food for at least 1,400 maximum crops, without drawing upon the supply of food material in the second foot or below.

6. "The continuous growing of wheat, or other grains, or cultivated crop, rapidly depletes the organic matter from the second six inches of soil.

7. "The growing of clover and peas in a crop rotation causes a marked increase in the organic matter and humus in the soil, in both the first and second six inches. These plants are also nitrogen accumulators.

9. "Land in crop rotation on which corn was grown in 1899, and wheat was grown in 1900, showed more than twice as much water in the first six inches, on July 14th, as found in soil continuously in wheat. In the second six inches there was sixty-three per cent more water. The yield of wheat was more than seven times as great.

10. "On July 14th the field on which corn had been grown the preceding year, contained 39 per cent more nitrates than for the continuous wheat field. On July 30th, the difference was even more marked being 61 per cent more of nitrates.

11. "Nitrifying bacteria in bare summer fallow were not found in the soil below two feet; probably not below eighteen inches.

12. "Nitrates were found in greater abundance at a depth of seven feet than at a depth of one foot.

13. "For every pound of nitrogen removed from the soil by wheat, we have lost from four to six pounds by other ways, where wheat has been grown continuously.

14. "Soils on which wheat has been grown continuously since 1883, are found to be in bad condition, chemically and physically. They do not retain water well in the cultivated portion, and failed to mature a crop of wheat in the dry season of 1900.

15. "The available plant food and the principal feeding ground of the wheat roots seems to be in the first eight inches of soil.

16. "A soil may contain a good supply of available plant food in the first eight or ten inches, and enough water lower down, but within reach of the wheat roots, and yet fail to produce a crop, literally starve, surrounded by an abundance of plant food for want of moisture in the first eight inches, to dissolve the food for the use of the plant.

17. "Plowing under a green crop does not produce as beneficial results as come from plowing grass lands. Plowing under a green crop leaves the organic matter in a mass and not uniformly distributed throughout the soil.

18. "After grass in a crop rotation, the soil shows a large increase in amount of organic matter but less than two-thirds as much as is found in adjoining fields of native prairie soil.

19. "Soils filled with a mass of grass roots furnish, in all parts of the soil, a uniform supply of organic matter, which by gradual decay, furnishes the soil humus. This humus, reacting upon the mineral constituents of the soil, seems to aid in liberating and rendering available this plant food.

20. "Newly broken soils do not blow. It is only after they have been cropped for a series of years, that soils begin to blow badly.

21. "The great mass of fine roots intertwined about the particles of soil in the virgin prairie prevented the soil from blowing. This mass of roots acted as pins to hold the soil in place. The decay of these fine roots removes the binding agents and permits of blowing. This is quite common on lands not well cultivated and in wheat continuously.

22. "Adopting a system of rotation which includes grass, will prevent the blowing by again returning to the soil the binding agents, the fine grass roots which serve as pins to hold the soil particles in place.

23. "Brome grass seems to put the soil more nearly in the condition of native prairie than timothy, while clover acts as a nitrogen gatherer to replace the legumes, common on virgin soil.

24. "The system of agriculture most nearly ideal for maintaining soil fertility would be one with two years in grass followed by cultivated crop, then two years in grain crops, making a five years' rotaton, then to be repeated."

FOOD ANALYSIS.

A large number of native food products are being analyzed, the results of which are not ready for publication at this time, but will form a part of a future bulletin from this department.

ACKNOWLEDGMENTS AND NEEDS.

During the past year, Mr. L. B. Greene and Adele Shepperd have been the assistants in the laboratory, dividing their time between college and station duties. Much of the analytical work has been done by my assistants in a most satisfactory manner.

The great need of the department is a laboratory suitable for doing station and college work in a manner commensurate with the demands made upon it for work. I trust that some arrangements may be made to give the department such quarters as are needed.

Respectfully submitted,

E. F. LADD,
Chemist.

DEPARTNENT OF BOTANY.

To Director J. H. Worst:

Sir: As in previous years the field work of this department has been chiefly limited to observations and experiments upon cereals and potatoes. Some observations, collections of specimens, and limited experiments have been made upon other types of plant study than those here reported, but are to be considered as matters of preliminary work.

WORK UPON THE WHEAT PLANT IN 1901.

The Selection of Wheat from the Individual Head: This is the fourth year upon this line of work, but the results obtained this season are of slight, if any value. The long continued drouth just following seeding time caused great irregularity in the first growths from the individual seeds, so that the observations made upon the growing plants are of slight comparative worth. Again, just previous to harvest time, a condition of blight struck the crop. The heads filled very irregularly. For this reason also the experiment was in part vitiated for comparative purposes. There is now sufficient data on hand to justify the publication of a bulletin upon this subject of selection from the individual head and plant. The work has emphasized to me the importance to the grain grower that he should use every economic method of seed selection which may tend to improve the strain desired. Summarizing the work of the four years, the actual records of the different features of growth indicate, in general, that: (1.) There is much difference in the development of the crop from individual plants. (2.) That even in the same head perfect grains of large size and greatest weight show some advantage over perfect grains of smaller size and of less weight. This is but further evidence indicating that ordinary methods of seed grading through the use of the fanning mill must tend to proper crop results. (3.) It is of the greatest importance that the grains sowed should be of high grade of quality. Indeed so far as the general farmer is concerned, I feel sure that the greatest importance should be attached to this matter of perfect quality of seed. An uninjured seed insures a strong first growth, which, other conditions being equal, is necessary to a large yield. (4.) The next point of importance which shows itself plainly is that a proper and even depth of seeding has very great effect upon the growth of the wheat plant. The results again

this year show that, when a grain of wheat is properly imbedded in the soil, the depth for best crop production is not far from one inch of cover.

Selection of Wheat From the Bin: The work of a comparative test of large and small grains of perfect form selected from the bin, was continued as in previous years. The observations upon strength of growth and other comparative matters correspond closely to those of the season of 1900. The data given in the eleventh annual report, pp. 30 and 31, I think furnish a correct idea of what is to be expected in this line. If the individual plants are considered, one may often find growths from the small grains which excel in strength and in quality of seed produced the average plants from the large select grains. These, however, I believe are to be considered as exceptions due to special strains within the variety. When the growths and products from all the grains are compared and arranged, it is found that the results are quite uniformly favorable to the large selects. It is to be remembered that in this work only perfect or ideal grains were used for seed, hand selected for size and weight, the average weight of the large grains being approximately twice the weight of the small selects. This experiment places much emphasis on the assertion that, in matters of yield of wheat, two very important factors are indicated in the terms varietal strain and perfection of seed quality. The latter feature may be easily governed by the farmer through ordinary methods. It is seen to be a matter of great importance when it is shown that the perfect small grains were excelled in yield by the perfect large grains approximately but 10 per cent. This difference is, perhaps, due to two elements: First, difference in strain; that is, the average small grain in a bin is apt to be from a parent plant which belonged to a strain which is in the habit of producing small grains. Second, to actual difference in strength to force a proper growth. Upon these points, see also results from the experiments upon selection of large and small grains from individual heads in this report p— and in eleventh annual report p. 30.

The Growth of Wheat From Immature Seed: The work of testing the value of mature and immature wheat for seed purposes was continued again this season. The results are very plain. Three samples of grain were saved from the crop of 1901 as follows: No. 1. Very immature. The grains were in the milk stage. No. 2. Quite immature. The grains were in a soft doughy stage. No. 3. Thoroughly mature. The grain was allowed to stand until dead ripe, one month after the first cutting. The straw was cut by hand in 1900 and the grain was cured in the head without exposure to weather, thus insuring uninjured embryos. A test of germination strength was made in a Geneva germinator on date of April 20, 1901, with the following results per 100 grains: No. 1. Fifty strong, forty-two medium and

eight weak growths. No. 2. Sixty-two strong, thirty-six medium and two weak growths. No. 3. Fifty strong, thirty-four medium and fourteen weak growths, and two dead grains.

It is again seen that wheat which is not thoroughly mature may under good conditions show a higher percentage of germination and a more rapid response to moisture than thoroughly mature grain. The results at harvest and the growth from the start in the field, however, show the immature seed in unfavorable comparison. All seeds, 800 of each type, were planted under like conditions on the date of April 30, and were harvested by hand pulling on the date of August 1. The season following seeding time was a trying one to young plants, and those from the mature seeds showed from the start a very much stronger growth. A difference in width of leaf surface and height was easily seen at a distance. The following harvest records show what was done by each group of grains:

No. 1 produced 326 stools, the dried heads from which weighed 552 grams.

No. 2 produced 433 stools, the dried heads from which weighed 943 grams.

No. 3 produced 575 stools, the dried heads from which weighed 1,402 grams.

While the weak, immature grains readily gave a high percentage of growths in the germinator, over 50 per cent failed to produce mature plants in the field under the trying conditions of a spring drouth.

On the Use of Injured Wheat for Seed Purposes: The very rainy autumn of 1900 injured the quality of much of the grain harvested in the state. The injury, in most cases, was primarily due to the influence of water upon the seed after maturity. Much of the grain was wet for a long time in the shock or stack. Some of it was thrashed damp and remained damp and soft in the bin, subjected to freezing and thawing and yet other samples were injured by heating in the stack or bin.

Some hundreds of samples were sent to the station for examination, the senders asking for a report upon the value of the samples for seed purposes. In all 560 samples of wheat and flax were tested in the laboratory to determine their seed value; and letters were written giving advice in the premises. It is unfortunate that there are many farmers who have a general impression that grain which is rejected upon the market may yet be used with good success for seed purposes. The experiments published by this department in Bulletin No. 13, April, 1894, were very strongly against this proposition; but the fine lot of injured samples on hand last spring gave an opportunity to test the matter more exactly. The following method was followed. Each sample of seed was hand picked so as to exclude broken and shriveled grains which would ordinarily be removed in the process of

grading or cleaning by the fanning mill. Germinator tests were then made in duplicate, using 100 grains for each test. In considering these tests each grain was examined, and the growth listed as strong, medium, weak, or dead, according to the results. This, together with a careful inspection of the general character of the grain, allowed us to make a judgment as to the value of each sample for seed. A number of injured samples were saved for trial in the experimental garden. The accompanying table gives the characteristics of these samples, and the yields from the same as indicated in stools matured, and the weight of clipped heads. All were planted on April 25, the grains being placed one and a half inches deep, one inch apart in the row and ten inches between the rows. Weeds were kept pulled and all plants were harvested by pulling upon date of July 30th. After curing a few days, the heads were clipped off and cured in paper sacks. When thoroughly dried, these were weighed. This weighing was done at two different dates. The averages of these two weighings furnish the figures given in column seven of the table. Eight hundred grains were planted in each bed. In order to test the question of injury more certainly, some samples were hand picked into three lots of 800 each. These are listed as (a), (b) and (c) in the table. Column (3) explains the type of each. (See table next page.)

The results from the experiments give a number of interesting facts, though the drouth following the date of seeding was intense. It seems, indeed, that the drouth was favorable to the soft seed. Many such came up quicker than the hard selects. Such soft seeds, however, were found to decay quickly in soil purposely made quite moist, while the hard seeds survived. The yields in the field from such injured seed for one season should not therefore be taken as a criterion. The reason that the soft seeds seemed to fare better than the hard ones was probably due to the fact that the soil was so dry that it could not furnish sufficient moisture to properly start a hard dry seed, while the soft seeds were actually favored by the dryer conditions. The latter certainly would have tended to early decay in a moist soil. Usually the number of stools and the yield seemed to follow rather closely upon what would be expected from the laboratory germination test; but it is interesting to observe that the growths in the field were much less in number than indicated by the germination test. Upon this point, compare the per cent of germinations given in column six with those under the term total in column four.

A Table for the Comparison of the Value of Different Samples of Injured Wheat for Seed Purposes in 1901.

Column 1	Column 2	Column 3	Column 4					Col. 5	Col. 6	Col. 7
No. of Sample and Address of Sender	Kind of Wheat	Type of the Injury and Noticeable Characteristics	Germination Test					No. of Stools in Field at Maturity	Per Cent of Grains which Matured Plants	Weight of Dried Heads in Grams
			Strong	Medium	Weak	Dead	Total			
1—J. K. Knight, Grandin	Blue Stem.	Bleached some	4	31	65	..	100			
(a)	Blue Stem.	800 best amber colored grains	..	..	..	..	...	480	60	855
(b)	Blue Stem.	Extra large but weathered grains	..	..	..	..	...	517	64	1032
(c)	Blue Stem.	800 grains of average size and quality	..	..	..	..	...	530	66	1038
2—M. Kanna, Lidgerwood	Blue Stem.	Shriveled, dark in color and soft	6	21	64	9	91			
(a)	Blue Stem.	Best grains in the sample, 800	..	..	..	..	...	471	58	967
(b)	Blue Stem.	800 largest grains much bleached	..	..	..	..	...	421	52	946
(c)	Blue Stem.	800 grains of average size and quality	..	..	..	..	...	402	50	600
3—Asa Sargent, Caledonia	Mixed	Was damp and hot in bin; shriveled	4	23	59	14	86			
(a)	Mixed	800 best select grains	..	..	..	..	...	502	62	1372
(b)	Mixed	800 as badly bleached as possible	..	..	..	..	...	397	49	882
(c)	Mixed	800 grains of average quality	..	..	..	..	...	437	54	946
4—George Hexom, Hickson	Blue Stem.	Size and color good	7	25	65	22	98			
(a)	Blue Stem.	800 best grains in sample	..	..	..	..	...	553	69	1142
(b)	Blue Stem.	800 large much bleached grains	..	..	..	..	...	574	71	1172
(c)	Blue Stem.	800 of average quality	..	..	..	..	...	578	72	1292
5—W. O. Pickard, Niagara	Fife.....	Quite badly sprouted; soft	1	34	54	11	89			
(a)	Fife.....	800 best, soft appearing	..	..	..	..	...	637	79	1247
(b)	Fife.....	800 large, soft grains	..	..	..	..	...	482	60	985
(c)	Fife.....	800 of average selection	..	..	..	..	...	434	54	934
6—J. Schaefer, Cashel	Fife Mixed.	Weak sample, some sprouted	7	19	74	..	100			
(a)	Fife Mixed.	800 best grains	..	..	..	..	...	457	58	1016
(b)	Fife Mixed.	800 poorest living grains	..	..	..	..	...	415	51	1048
(c)	Fife Mixed.	800 average selects	..	..	..	..	...	475	59	1132
7—J. C. Stout, Gardner	Blue Stem.	Size and color rather good	36	38	23	3	97			
(a)	Blue Stem.	800 best amber colored grains	..	..	..	..	...	593	74	1254
(b)	Blue Stem.	800 large bleached grains	..	..	..	..	...	533	66	1388
(c)	Blue Stem.	800 grains of average quality	..	..	..	..	...	518	64	1187

8—B. F. Campbell, Conway	Fife	Light, shrunken grain; 800 grains of average quality and size	13	43	40	4	96	512	64	1092
9—Price Brothers, Buchanan	Mixed	800 grains of average quality and size, dark amber, irregular in weight	12	31	53	4	96	398	49	1234
10—H. E Styles, Seymour	Blue Stem.	Rather good color and size; 800 grains average quality and size	20	39	33	8	92	439	54	1181
11—Russell Mill Co., Jamestown	Mixed	Color fairly good; 800 grains of average quality	33	33	32	2	98	476	59	1159
12—Price Brothers, Buchanan	Mixed	Color and size fair; 800 selected amber colored grains	21	38	35	6	94	447	56	1185
13—O. W. Mathiesen, Wyndmere	Mixed	Wet in stack, but dry in bin; bleached	4	43	39	14	86	403	50	1195
14—A. Isenberger, LaMoure	Fife	Minnesota, No. 163, weak bleached sample, wet in stack	18	43	38	1	99	518	64	1491
15—Gray & Campbell, Sheldon	Blue Stem.	Rather weak, bleached and sprouted some; 800 average grains	12	33	46	9	91	393	49	1115
16—Gray & Campbell, Sheldon	Blue Stem.	Pedigreed Blue Stem, very weak; much bleached	9	36	50	5	95	432	44	1032
17—Gray & Campbell, Sheldon	Blue Stem.	Called Salzer's Marvel, sprouted; 800 best grains	7	30	57	6	94	390	48	1190
18—Gray & Campbell, Sheldon	Blue Stem.	Same as last; 800 large, soft grains otherwise sound	10	39	48	3	97	501	60	1214
19—College Farm	Blue Stem.	Weak sample; grain of small size	6	35	53	6	94	387	48	1299
20—Gray & Campbell, Sheldon	Blue Stem.	Grains selected of average size and quality	10	40	49	1	99	520	65	1218
21—S. Classon, Gardner	Blue Stem.	A strong, clean sample of soft appearance: 800 best selects	35	28	35	2	98	521	65	1370
22—R. F. Brekke, Edgeley	Fife	Grains of large size, but rather soft in appearance	6	26	49	19	81			
(a)	Fife	800 best grains in sample	..	..	..	..	...	602	75	1424
(b)	Fife	800 sound, soft, bleached grains	..	..	..	..	...	497	62	1424
23—College Farm	Blue Stem.	Good, strong seed	30	45	23	2	98	517	64	1358
24—Carl Peterson, Valley City	Mixed	Poor seed, had been wet and was slightly musty	13	29	15	43	57	344	43	957
25—H. Goehl, LaMoure	Fife	Rather large, soft and slightly damp	4	23	54	19	81	511	63	1387
26—D. L. Wellman, Frazee City, Minn	Fife	Wheat of light weight, good color, but shrunken and hard	30	27	38	5	95	406	50	1084
27—Russell Mill Co., Jamestown	Mixed	Sample hard and of good color	27	40	30	3	97	428	53	1340
28—H. F. Tufts, Argusville	Mixed	Large seed, has been wet and is soft; 800 best seed selected	0	15	18	67	33	220	27	969
29—College Farm	Blue Stem.	Good, strong sample of seed	..	..	..	..	...	458	57	1424
30—F. E. Vorachek, Conway	Blue Stem.	Grains of this sample were much bleached and sprouted some	.	43	31	26	74	66	8	285
31—Morton & Co., Fargo	Fife	This wheat was of good color, but irregular in size of grains	65	0	20	15	85	386	48	1256
32—R. Brealie	Fife	A musty and considerably sprouted sample	0	0	31	69	31	244	30	823
33—H. H. Walland, McCanna	Fife	A good, plump berry, which appears somewhat bleached	30	37	29	4	96	441	55	1225

The Growth of Wheat in the Field Compared With Laboratory Germination Tests: The following table is self explanatory. Only one sample, No. 13 of the table produced a greater number of stools in the field at harvest time than the germinator test indicated. One hundred grains per sample were used in each of the tests.

Sample	Laboratory Test					Stools Matured in the Field
	Strong	Medium	Weak	Dead	Total	
1—Joseph Bina, Conway.....	3	40	52	5	95	69, or 26 less than laboratory test
2—A. L. Peart, Emmbden.....	1	19	19	61	39	33, or 6 less than laboratory test
3—Sven Anderson, Rugby.....	9	52	32	7	92	82, or 10 less than laboratory test
4—G. B. Clifford, Grand Forks	15	45	31	9	91	77, or 14 less than laboratory test
5—E. S. Tyler, Fargo.....	22	48	26	4	96	74, or 22 less than laboratory test
6—M. Bliss, Lidgerwood.....	12	22	44	22	78	60, or 18 less than laboratory test
7—G. C. Holden, Thompson...	25	25	25	25	75	65, or 10 less than laboratory test
8—H. A. Britton, Casselton....	0	7	31	62	38	29, or 9 less than laboratory test
9—Iver Thompson, Portland..	..	..	..	..	83	71, or 12 less than laboratory test
10—R. B. Montgomery, Inkster.	0	26	46	28	72	68, or 4 less than laboratory test
11—S. J. Sandness, Larimore...	9	22	32	37	63	46, or 17 less than laboratory test
12—J. M. Thompson, Ayr.....	7	11	26	56	44	41, or 3 less than laboratory test
13—T. H. Bubach, Griswold....	3	11	27	59	41	42, or 1 less than laboratory test
14—E. T. Curtiss, Fargo.....	12	22	64	2	98	75, or 23 less than laboratory test
15—Unknown, Jamestown.....	9	15	58	18	82	70, or 12 less than laboratory test
16—John Muir, Inkster.....	10	19	44	27	73	59, or 14 less than laboratory test
17—O. P. Dahlien, Kindred.....	42	22	27	9	91	58, or 33 less than laboratory test
18—M. C. Fitzgerald, LaMoure.	17	25	55	3	97	71, or 26 less than laboratory test

Summary: (1.) Field conditions in 1901 were distinctly less favorable for the growth from the seed than those which are given by the common Geneva germinator used at ordinary room temperature. The soil remained cold and dry for over one month following seeding time. Many seeds which would have been otherwise good died. (2.) In the eighteen samples tested, the difference between the number of stools matured in the field and the number of sprouts per hundred grains which grew in the germination tests was on the average approximately twelve. (3.) The smallest single difference was thirty-three growths in favor of the germination pan. (4.) This experiment confirms previous observations upon this subject. For the wheat plant the Geneva germinator will usually produce fair growths from some seeds which are too weak to produce plants under field conditions. (5.) This experiment and those connected with the study of the use of injured wheat and flax for seed indicate quite plainly that properly conducted germination tests are of much value to farmers. If there is any doubt of the viability, one cannot afford to sow large acreages with such seed. This is especially true in regard to flax, a seed which may be badly damaged without much change in appearance. Flax may also vary greatly in color and yet possess good strength for growth.

WORK WITH FLAX IN 1901.

Germination and Field Tests of Injured Flax Seed in 1901: A number of seeds of average size and quality were taken from each of many samples of injured seed sent to the college during the spring. Eighteen samples of varying character were selected from these upon which to make comparative trials to determine the efficiency of germinator tests. One hundred seeds from each sample were tested in a special germinating pan for flax seed. Eight hundred seeds from each were planted on May 24th in beds so that the individual seeds were approximately one-inch deep, one-fourth inch apart in the row, and ten inches apart between the rows. The crop was harvested by pulling on September 4th.

TABLE SHOWING GERMINATOR TESTS OF FLAX SEED IN CONTRAST WITH TESTS OF THE SAME TYPE OF SEED IN THE FIELD.

Sample	Character of Injury	GERMINATOR TEST					Plants matured in field	
		Strong	Medium	Weak	Dead	Total	Number	Per Cent
1—A. F. Miller, Wagar.	Brick red, due to heating in bin	3	8	26	63	37	3	3.0
2—W. O. Pickard, Niagara.	Had been damp; rather dark brown in color.	0	24	48	28	72	93	12.0
3—W. O. Pickard, Niagara.	Brick red, due to heating while damp	4	20	48	28	72	105	13.0
4—Gray& Campbell Sheldon.	Light weight, dark colored, weak seed	0	11	63	26	74	47	6.0
5—Gray& Campbell Sheldon.	Poorest living seeds in last sample	..	..	..	..	..	50	6.0
6—Gray& Campbell Sheldon.	Seeds of average quality and size, as above	..	..	..	..	..	55	6.5
7—G. Miller, Litchfield.	Very dark colored; not recommended	7	12	14	67	33	81	10.0
8—William Ross, Fargo.	Dark colored, weak and scaly	..	20	32	48	52	76	9.5
9—H. H. Walland, McCanna.	Large plump, well-colored seeds	91	..	..	9	91	234	29.0
10—Iver Thompson, Portland.	Immature, dark, scaly; 800 darkest	40	14	14	32	68	none	....
11—P. P. Lee, Minot.	A heated sample; 800 large, red seed	12	16	12	60	40	none	....
12—P. P. Lee, Minot.	800 best seeds in sample	42	14	16	28	72	33	4.0
13—G. A. Luce, Hope.	Slightly dark, some immature; injured	68	14	8	10	90	65	8.0
14—M. L. Elken, Mayville.	Light weight; color good	26	61	9	4	96	78	9.7
15—Kraabel & Co. Hope.	Light weight; dark, scaly, immature	..	28	52	20	80	no crop	....
16—J. M. O'Neal, Grand Forks.	Size normal; color good	56	22	10	12	88	109	13.0
17—A. L. Holcomb, Minnie Lake.	Brick red in color; had been heated	2	26	30	42	58	no crop	....
18—Jas. Scott, Hope.	Immature; all dark, scaly	0	1	7	92	8	no crop	....

Summary. (1.) Intense drouth following seeding time lessened the number of plants produced in the field, even by seed of best quality. (See for e. g. No. 9 of table.) A surprisingly low number out of the 800 seeds succeeded in producing plants to maturity. The highest per cent of growth represented in these experiments was 29.

(2.) Flax which has been damp and more or less heated takes on a brick red color. Such flax is of very poor seed value. (See samples 1, 3, 11 and 12 of table.)

(3.) Immature scaly flax was worthless in the soil condition of the past season. (See samples 10, 15 and 18 of the table.)

Flax Wilt: A large part of the time allowed for investigation has been given to a study of the life habits of the parasitic fungus which produces this disease. Many of the experiments planned were successful in throwing light upon the matter. The fungus is a species of fusarium, and like many of its relations shows marked ability to spread through and develop in the soil. For further information upon the work accomplished, see the preliminary report in eleventh annual report of this station, page 45, and Bulletin No. 50 upon "Flax Wilt and Some Minor Problems Affecting Flax Growing."

Flax Selection in 1900 and 1901: Realizing how important an element intelligent selection has been in the improvement of garden plants, an effort has been made to answer the question: Can flax be improved by the selection of seed from individual plants? The seed for twenty-nine tests was selected from various fields during the season of 1900. Besides a number of selections made because of apparent botanical variations noticed, such as leaf width, mode of branching, flower characters, etc., others were made for the purpose of contrasting such features as earliness versus lateness of maturity, long stems versus short stems, even ripening versus irregular ripening, strength of stem versus weakness of stem, etc. The product of each plant was kept separate and was planted upon the same date in 1901, under good conditions for comparison. The results give marked assurance that flax will respond very readily to proper methods of selection. (For the details of these experiments see Experiment Station Bulletin No. 50, now in course of publication.)

Shallow Versus Deep Planting of Flax: In the eleventh annual report, pages 44 and 45, some results are given from an experiment in which different samples of seed flax were used for planting at different depths. This gave opportunity to observe the effect upon after growth. A study of such growths leads to the conclusion that deep planting was always detrimental upon all dates of planting tested. The injury due to planting deeper than one and one-half inches was always apparent upon the after growth. The growth of flax in the field throughout the Red River Valley was especially weak in starting from the seed during the

spring of 1901. There were many total failures over large areas. In a number of cases I was called upon for a possible explanation. Very often I found that the seed used had been of rather poor strength, but in nearly all cases the chief cause of failure, when failure to produce a stand was total or nearly so, I found to be due to deep planting. Many farmers used summer fallowed land upon which to sow flax. The soil was light, loose and deep. The drills when set as shallow as possible sank deep into the soil. Very much flax was put down four or five inches. In the experiment just cited, in 1900 it was proved that the best flax seed cannot force the seed leaves above the surface of the ground when planted to a depth of from four to four and one-half inches, at least not in sufficient strength to make an aftergrowth. I believe this is a most important question to flax growers. All my observations cause me to believe that the seed bed for flax should be as firm as possible and that the depth of planting should if possible not exceed an inch of dirt cover.

WORK WITH POTATOES IN 1901.

The work of potato selection from the vine was continued in 1901. Fourteen experimental plantings were made, including selections from seven varieties. The heavy rains in July did much damage, making a part of the experiment of slight use for comparative purposes. The general results bear out the conclusions in Bulletin No. 30 and those cited in previous reports. There is now sufficient data collected covering the work with potatoes to warrant the publication of a bulletin of general information. Continuing the accumulation of facts upon the question of breeding, the following point may be recorded:

(1.) It is not easy in selecting to develop shape or form away from what may be called the normal type of the variety. For example, one must not expect to raise round tubers from a tuber which happens to be round, if found in a hill which normally belongs to a strain which habitually produces long or linear formed tubers. A tuber which, for example, happens to have a particular shape because of some mechanical condition of the soil, cannot reasonably be expected to produce tubers like itself in shape when planted in soil of normal mechanical type.

In regard to the stem and tip end question, the following summaries are interesting:

1. The stem ends excelled in number of stalks per hill thirty-one times.
2. The tips excelled in number of stalks per hill twenty times.
3. The tips and stem ends were equal in number of stalks per hill twenty-nine times.

1. The stem ends excelled in number of tubers per hill forty-four times.

2. The tips excelled in number of tubers per hill twenty-nine times.

3. The tips and stem ends were equal in number of tubers per hill seven times.

1. The stem ends excelled in weight per hill forty-four times.

2. The tips excelled in weight per hill twenty- nine times.

3. The stem ends and tips were equal in weight per hill seven times.

The number of hills thus contrasted was eighty.

The total weight of tubers from stem ends was 3,399 ounces.

The total weight of tubers from tips was 3,290 ounces.

The average weight per hill from stem pieces was 84.93.

The average weight per hill from tip pieces was 82.2 ounces.

The approximate difference per hill was thus 2.7 ounces in favor of the pieces from the stem ends. In 1900 this average difference was approximately three ounces per hill in favor of the pieces from the tips.

The general conclusion upon this matter of potato cutting drawn from the experiments conducted for several years must be that the two ends of a potato tuber are practically equal in value for planting purposes.

Root-Fusion in Potatoes: Tests upon this question were placed upon a more exact and extended plan than that which was reported upon in the eleventh annual report, page 42. An attempt was made to associate seed pieces from varieties of essentially the same life period (earliness) in the same hill. The varieties placed together were of such distinctive features that any fusing of characters dependent upon root-fusion or grafting might be apparent. The method of associating the pieces planted was as in 1900.

Twenty hills were planted in each experiment, and the following pairs or combination tubers were made:

Group No. 1. Triumph and Six-weeks, Triumph and White Ohio, Triumph and Red Russet, Triumph and Early Ohio.

Group No. 2. Thoroughbred and Rural New Yorker, Thoroughbred and Maine crop.

Group No. 3. Freeman and Burpees Superior, Freeman and Thoroughbred.

Notes: Generally both pieces produced stalks. These were usually quite distinctive. The difference between the varieties was usually quite apparent, either in stems, flowers, or the young tubers just setting. At digging time one kind of tuber and vine often quite predominated in individual hills to the exclusion of those of the associated variety, but such tubers show no essential variation from type. There appears to be no root grafting or fusion between varieties, at least none could be found during the earlier periods of growth nor at digging time.

If potatoes may thus tend to cross breed, there is no appearance in the first year growth which would confirm the idea. Some tubers from the different groups have been saved for a second test. If, from a single one of these, a growth different from either parent or a mixture of tubers should result, the old thesis "mixing in the hill" might have some evidence to stand upon.

MISCELLANEA.

Vitality of Weed Seeds Planted Different Depths in the Red River Soil in 1899: For previous records of growths made by these seeds, see tenth annual report, pages 26 and 27, and eleventh annual report, pages 53 to 55. The seeds came up this season in but limited numbers. Examination of the beds made upon June 13th showed the following growths: Seeds of Shepperd's Purse (Capsella) produced forty-seven growths from one and two inch plantings. French weed (Thlaspi) produced fifty-four plants from a depth of one inch of original planting, and thirteen plants from the two-inch planting. Pigeon grass seed (Setaria) showed no growths from any depth. King-head (Ambrosia) gave an interesting number of plants. Twenty-five plants from depth of one inch. One hundred and sixteen plants from depth of two inches. Twenty-nine plants from depth of three inches. Fourteen plants from depth of four inches.

There were no plants from greater depths in this bed.

Wild buckwheat (Polygonum) produced no plants from any depth. Wild oat (Avena Fatua) produced eight plants from depth of two inches, none from other depths.

On date of October 7, 1901, one plant of King-head came up from a depth of three inches and one plant of mustard from a depth of three inches in bed No. 5.

June 14th Germination Tests Were Made Upon These Seeds as Follows: 1. Capsella Bursa pastoris (Shepherd's Purse) seventy-six growths from seeds taken from ten inches deep. Percentage of vitality not determined.

2. Thlaspi arvense (French Weed.) From a very large number of seeds in the mass of dirt taken from seven inches deep, only five growths occurred; fifteen growths occurred from the mass of dirt taken from ten inches deep. The percentage of viability was not determined.

Out of twenty-five seeds taken from a depth of seven inches none grew.

Out of fifty seeds from the mass taken at ten inches deep, two seeds grew equal 4 per cent.

Setaria viridis (pigeon grass) 100 seeds taken from a depth of 7 inches produced 34 plants and 100 seeds from a depth of 10 inches showed a vitality of 20 per cent.

From the mass of dirt (7 inches of the seed bed) from a depth of 5 inches, 382 plants grew.

From a like mass from a depth of 10 inches there grew 198 plants.

Ambrosia trifida (king head). A test of fifty seeds taken from a depth of 7 inches gave an 8 per cent viability.

In the case of 50 seeds taken from 10 inches deep, there was 22 per cent of growths.

Brassica sinapistrum (mustard). Of 100 seeds from a depth of 10 inches, there were 20 per cent of viable seeds.

Of 100 seeds from a depth of 7 inches, there grew 71 plants.

Polygonum convolvulus (wild buckwheat). A test of over 300 seeds taken from a depth of 7 inches and 10 inches found all seeds thoroughly decayed.

Avena fatua (wild oat). Many seeds were taken from a depth of 10 inches. All were decayed.

Notes: The soil upon which these beds are placed lies very low. A depth of one foot was sufficient to reach water at almost any season of the year. The conditions for the survival of the seeds can hardly be thought so good as those usual to regular farm soils. The greatest depth from which a seed put up a plant this year was 5 inches in the case of kinghead, and three inches for a mustard seed.

Miscellaneous Plant Diseases:—As the agricultural soils of the state grow older, it becomes apparent that the parasitic diseases of cultivated plants are brought in with the seeds, and in other ways which are closely associated with the general farm operations. The farmers of this new state should as quickly as possible appreciate this fact. The worst plant diseases are not native to the virgin soils. "Clean and healthy seeds" should be a watchword here. As examples of diseases which have lately been introduced, one may call attention to the potato rot (phytophthora) and asparagus rust. The first named is a most destructive disease, and it would mean much to potato growers to be able to hold it in check. While it may be distributed by the wind, its habits and nature are such that it is more liable to reach a new locality by way of potato tubers used for planting. If the weather is favorable it may then spread rapidly. The asparagus rust first appeared at Fargo and other points in the state in the summer of 1899. Last year the disease was intensely destuctive, killing almost every plant early in August. This disease spreads by way of the wind. At present about the only known way of checking its ability to do harm is to cut and burn all old asparagus brush each autumn. Spraying has been shown to be effective but is a very costly work for this crop; it would, however, pay those who are raising this plant in large quantities for market.

Wheat smut (Tilletia) was very desctructive in fields in which infested but untreated seed wheat was planted.

The experiment upon injured wheat described elsewhere in this report gave an opportunity to take some notes. One interesting

point was that some of the seeds produced quite a high percentage of loose smut, while others were free from the disease. Thus while it is usually considered that this sort of smut is spread through the fields of young growing wheat by way of the wind, the point of attack being at the nodes, there is here given some indication that one of the chief ways of infection is by way of the seed as in the case of stinking smut.

A rust on flax produced a considerable amount of damage this season (See description in Bulletin No. 50).

Correspondence: The correspondence of the department has increased over that of previous years, showing perhaps a wider interest in matters pertaining to plant life. The following summary of letters answered since last report will indicate in a manner the nature of the queries received:

Germination tests of seed grain	601
Letters upon general matters from outside the state	176
Letters upon general matters from inside the state	62
Requests for special Bulletin No. 46	107
Determination of weeds and other plants	68
Insects, worms, etc., attacking plants	26
Grasshoppers	17
Water hemlock	16
Smuts of cereal grains	25
Analysis of diseased animal tissues	5
Plant diseases	5
Examinations of milk and water for bacterial content	7
Total	1,115

Assistance and Equipment: Mr. L. R. Waldron has been on leave of absence from the college since June, 1901. Upon his return in September, the working force of this department of the college and station will be such as to allow more time to be devoted to station work. In the absence of Mr. Waldron, Mr. Thomas Manns, as a student assistant, has given efficient aid in several lines of investigation.

January 1, 1902, finds the department of botany and zoology of the college and botany of the experiment station housed in new quarters especially planned for the work. There are the following rooms:

1. The general biological laboratory 27x45 feet, associated with which are dissection and preparation room, 10x20 feet, and a store and locker room 11x11 feet.
2. The herbarium and botanical laboratory 27x32 feet, with store room 7x10 feet.
3. An office and library room 14x27 feet.
4. The station and bacteriological laboratory room 27x32.

Each of the three large rooms is well lighted upon two sides.

The station laboratory has good hood and a fine glass culture cage. This room is in every way well equipped for its purpose. To further the interest of student and experimental work with plants, there is planned a small green house 20x30 feet, to be connected with the general laboratory by a door leading to the south. This will be large enough to furnish plants for student use, and also a space for exact control of certain experiments in the study of plant diseases and physiology. This green house is very much needed and it is hoped may soon be constructed.

Respectfully submitted.

HENRY L. BOLLEY,
Botanist.

AGRICULTURAL DEPARTMENT.

To Director J. H. Worst:

Sir: In making the twelfth annual report of this department, I desire briefly to recount the lines of investigation which have engaged the attention of its workers during the year and will give a more extended report upon such portions of it as have not been handed to you as bulletins, except such material as is being held for future publication in bulletin form.

The destruction of the combination horse and cattle barn by fire on January 4, 1901, left the department no opportunity to carry on further trials with horses or cattle until about January 1, 1902. New barns were not ready for occupancy until September, and the collection of minor but necessary pieces of apparatus for feeding trials required additional time.

A study in growing and fattening pigs under local conditions has been successfully carried forward and I expect to be able to hand you a detailed report in bulletin form after the trial is carried long enough to be conclusive.

Pasturing trials with sheep which were undertaken during the season were interefered with to some extent by the serious flooding of the station grounds during the season. Important data was secured, however, and I hope to be able to present it in bulletin form together with the unpublished results of trials made in other years, at some future time.

Conducting stock judging tours with animal husbandry students, assisting in farmers' institute meetings and helping to

instruct farmers excursion parties which have visited the station grounds during the past year has occupied about one-fifth of the time which I have had to devote to both the college and station, while my assistant has spent a similar proportion of his time in institute work, in conducting excursion parties and in preparing and placing exhibits.

The answering by correspondence of specific inquiries relative to farm problems has materially increased over that reported for last year, but the clerical aid which you have provided makes correspondence enough more expeditious to offset the increase in its volume.

As heretofore the breeding, testing and manner of seeding, studies, with cereal crops has been given a prominent part of the effort expended by the department. Macaroni wheat an emmer or spelt are two of the newer plants brought forward which seem to show special promise for the portions of the state to which they are particularly well adapted.

Among the forage crops, corn, millet, the more promising grasses, clover and alfalfa have received careful study. The breeding work with clover and alfalfa thus far has resulted in a fair degree of progress, but where selection toward hardiness and acclimation are the ends sought progress while valuable and important is of necessity slow.

The bureau of plant industry of the United States department of agriculture has entered into co-operation with this department and furnished red clover seed from fifteen different states and countries for trial. Seed thus provided was sown last spring and is now under careful study.

The department has other stocks of alfalfa and red clover seed which are descended from plants which have proved hardy enough to withstand the conditions of the more trying seasons. The department is constantly upon the alert for valuable introduced things. One of the more promising new things is Turkestan alfalfa described elsewhere in this report. The cultivation methods and soil moisture study has given asl arge returns in valuable dadt for the expenditure of time and money by the department as has any line of experimentation conducted by it. Bulletin No. 48 which consists of a report upon that study has been well received and has taught our people a valuable lesson.

Root studies with wheat have been made during the season at Fargo and at Edgeley and have given interesting results. The rotation trials increase in value as time permits of additional studies. The work with flax whch I inaugurated eight years ago has proven an especially valuable study and of late has engrossed the botanical department in as strong and valuable a study as it has this division. The department has made few changes in the rotation trial plots and has secured good results, as is shown by a recent publication.

The seed exchange trials, which the fire of 1901 interfered with have given rather conclusive results which have tended to check a too common custom of changing seed for change sake.

PLANT BREEDING AND SEED DISTRIBUTION.

During the past season 17,230 individual plants were produced in the plant nursery for breeding and selection.

That number includes 7,430 individual wheat plants, 730 of which are included in a co-operative trial with the chemical department of this station and are from plants which have been analyzed while the seed from the plants grown has also been subjected to chemical analysis in order that a hereditary or breeding study of the chemical constiutents may be made.

Of the other cereals, 15,830 plants were grown which consist of the following: Oats, 2,400 plants; barley, 1,600; flax, 2,000; buckwheat, 1,200 and millet 1,200 plants.

Following is a list of the forage plants grown in the plant nursery: Eight hundred alfalfa plants, 300 brome grass plants and 300 slender wheat grass individual plants.

The seed from the best plants is saved and increased and passed through the variety trials against other kinds, and those which prove to be superior strains are distributed by sale.

The department has been longest working with wheat and hence is further along with it than with any other plant. The records show that 499 bushels of pedigreed wheat have been distributed by sale in 126 separate lots to as many addresses. It has thus passed into twenty-eight counties in the state. The loss of a large quantity of the increased seed of pedigreed oats, barley and other plants in the fire which destroyed the college barn Jan. 4, 1901, caused a delay of several years in the time of distribution of some of these sorts, as that accident reduced the quantity of seed in some instances from twenty-five bushels to an ounce or less.

The appointment of the writer as a collaborator in the bureau of plant industry of the United States department of agriculture and the appointment of Mr. E. G. Schollander as special agent of that department, to be paid by the United States department of agriculture, to aid in the co-operative work at the station is substantial recogniton of the work accomplshed and now under way. The additional efficient aid thus given has enabled the department to extend and systematize the work. One hundred bushels of choice seed corn representing eight years work in breeding and selection upon the station grounds has been stored and dried by artificial heat, and is now being distributed in suitable districts in the state. The department will also send out a considerable quantity of wheat of good fife and macaroni types, and 100 bushels of a well bred variety of potatoes.

GRAIN AND FORAGE CROP EXHIBITS.

This department has expended considerable time and energy in preparing and placing educational exhibts which were arranged to convey an intelligent idea of the work which this station has done and of the results accomplished in breeding and introducing the above named classes of crops.

A comprehensive exhibit of that character has been maintained in a prominent place in Fargo during the entire year. Exhibits were made at the state fair at Mandan and at the harvest festival or fair at Casselton. An exhibition is also in place at Edgeley which comprises chiefly the representation of trials made upon the Edgeley sub-station grounds during the season of 1901.

This department in conjunction with the horticultural department of the station, furnished a large amount of material for the display of plant products made at the Pan-American exposition held in Buffalo, New York, during the past season.

An exhibit of the stock foods produced by this station was made at the international live stock exposition held in Chicago, November 30th to December 7, 1901, and an arrangement was made for it to be placed upon exhibition in Chicago where it will remain permanently. These exhibits have attracted large attention, have strongly represented the work of the station and have proved attractive and very welcome additions to the exhibitions of which they have constituted a part.

In each case the department has been strongly urged by those in charge to take a similar part in future exhibitions.

I believe this line of endeavor is bringing good returns to the station, and that it should be continued. A. M. Ten Eyck and L. F. Seneco have had charge of the details of this line of work, and the degree of success which the enterprise has secured is an indication of their ability in that direction.

TURKESTAN ALFALFA.

A plat of land two and one-third acres in extent was sown to Turkestan alfalfa on May 21, 1901, at the rate of fifteen pounds per acre. The seed used was purchased from Currie Bros., seedsmen. The seed was sown broadcast upon old land which had been in a timothy and clover meadow for several years. This plat has been broken the fall before; was in good tilth which permitted the seed to be harrowed in reasonably well. On July 2, twelve days after sowing, the young plants stood two inches high, constituting a good stand. Later in the season the plants growing in small groups from two to ten feet across, and irregular in form took on a yellowish hue and failed to grow as rapidly as their neighbors. That condition was probably caused by the water standing upon the spots so affected—shorter or longer periods—during the growing season.

On August 2nd the plat had a fair hay crop upon it, but it was somewhat weedy in places with pigeon grass or fox tail and amaranthus or red root. The alfalfa was twenty to twenty-two inches high except in the yellow groups where the plants had only a height of from six to ten inches. A few of the plants were showing blossoms upon the above date. The effect of the winter season upon this plat is awaited with interest. Promising results are reported for it from a few places in the state where it was planted in the spring of 1900.

VARIETIES OF GRAIN.

WHEAT.

Thirty-eight varieties of wheat were grown in the field trial in 1901. Seventeen of these were varieties of macaroni wheat secured mainly from the United States department of agriculture. The others were chiefly strains of fife and blue stem, which were obtained from the various seedsmen and from the Minnesota experiment station. These varieties were all new seed. The seed of the old varieties was nearly all lost in the fire, which destroyed the station barn in January, 1901. Fortunately small packets of seed of some of the best old varieties and also of several new ones, which this station had bred up and was preparing to propagate in a field way were stored in another building. This grain was sown in small plots last season and enough seed has been secured to continue the field trials in 1902 or 1903.

The land used for the field trial last season grew a crop of corn in 1900 and was not plowed, but the ground was disc pulverized twice (lapped one-half), just before seeding. All of the varieties were sown on April 26th and 27th. The rate of seeding was five and one-half pecks per acre. The wheat was not treated for smut. On May 2nd, just as the wheat was beginning to come up, the field was rolled and harrowed. This left the soil in excellent condition and free from weeds. On July 2nd it was noted that some varieties of wheat were in full head and that nearly all varieties were heading. The wheat had stooled well and the stand was excellent. The very heavy rains of July 4th and 5th damaged the crop and the heads failed to fill well. The fife varieties seem to have been injured the most, while the macaroni types were the least affected by the wet weather. There was little difference in the varieties in the ripening period. Harvesting was begun July 31st and completed August 3rd. The results of the trial are given in table 1.

Table I.—Varieties of Wheat—Crop of 1901.

Bulletin Number	Variety	Class	Where From	Days Maturing	Length of Stem—Inches	Bearded, Smooth, or Velvety Chaff	Length of Heads—Inches	Grain			
								Grade *	Hard Wheat—Per Cent	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
247	Minnesota, No. 185, Advance	Cross Bred	Minnesota Exp. Station	96	34	Bearded.	2½	2 N.	80	58½	19.7
248	Minnesota, No. 188, Preston	Cross Bred	Minnesota Exp. Station	97	39	Bearded.	2¾	3 N.	80	58¼	25.7
249	Minnesota, No. 149, Selected Powers	Fife	Minnesota Exp. Station	97	36	Smooth..	2½	3 N.	95	57½	22.8
250	Minnesota, No. 155, Selected Glyndon (818)	Fife	Minnesota Exp. Station	97	36	Smooth..	2½	3 N.	95	58	25.3
251	Minnesota, No. 171, Selected Rysting's	Fife	Minnesota Exp. Station	97	39	Smooth..	3	3 N.	95	58	26.0
252	Minnesota, No. 181, Selected McKendry's	Fife	Minnesota Exp. Station	97	38	Smooth..	3	2 N.	95	58½	27.1
253	Saskatchewan	Fife	Northrup, King & Co	97	37	Smooth..	2½	3 N.	90	58¼	27.2
254	Pillsbury	Fife	Northrup, King & Co	97	36	Smooth..	2½	3 N.	90	58	26.9
255	White	Fife	Wm. Rennie, Toronto	97	36	Smooth.	2½	3 N.	85	58	26.2
256	Red Fern	Fife	Wm. Rennie, Toronto	97	37	Smooth..	2¾	3 N.	85	57½	26.5
257	Minnesota, No. 285	Fife	Minnesota Exp. Station	98	41	Smooth..	3	2 N.	95	60	29.9
258	Minnesota, No. 288	Fife	Minnesota Exp Station	98	39	Smooth..	2⅝	2 N.	95	58	24.9
259	Minnesota, No. 292	Fife	Minnesota Exp. Station	98	38	Smooth..	2⅜	2 N.	80	58½	24.1
260	Minnesota, No. 293	Fife	Minnesota Exp. Station	98	39	Smooth..	2⅝	2 N.	95	58½	25.6
261	Experiment Station, No. 66	Fife	John Davis, Buxton, N. D.	97	38	Smooth..	2½	3 N.	95	57	27.0
262	Haynes' Pedigree	Blue Stem.	L. H. Haynes, Fargo, N. D.	99	40	Velvety..	3	2 N.	95	58	28.1
263	Marvel	Blue Stem.	John A. Salzer Seed Co	99	40	Velvety..	2¾	2 N.	95	58	28.4
264	Haynes'	Blue Stem.	Minnesota Exp. Station	99	40	Velvety..	3	2 N.	96	59¼	29.7
265	Bolton's	Blue Stem.	Minnesota Exp Station	99	40	Velvety..	3	2 N.	95	59	29.7
266	Selected Haynes'	Blue Stem.	Minnesota Exp. Station	99	40	Velvety..	3	2 N.	95	59½	30.2
267	American	Blue Stem.	Wm. Rennie, Toronto	98	41	Velvety..	3	2 N.	95	59	30.5
268	Aronautka	Macaroni..	I. N. Oium, Lisbon, N. D.	99	42	Velvety..	2¼	2	90	62	34.0
269	Wild Goose	Macaroni..	Wm. Rennie, Toronto	99	42	S. beard.	2	2	90	62	33.1
270	Berdianska, U. S., No. 1586	Macaroni..	Russia, from Marseilles, France, by U. S. Department of Agriculture	95	40	S. beard.	2	2	80	60½	29.6
271	Novorossisk, U. S., 1567	Macaroni..	Russia, from Marseilles, France, by U. S. Department of Agriculture	96	39	S. beard.	2	2	90	61½	33.4
272	Algerian, U. S., No. 1568	Macaroni..	Marseilles, France, by U. S. Department of Agriculture	95	40	S. beard.	2	....	..	....	22.8
273	Argentine, U. S., No. 1740	Macaroni..	Marseilles, France, by U. S. Department of Agriculture	96	40	S. beard.	2	....	..	....	28.4
274	Taganrog, U. S., No. 1570	Macaroni..	Taganrog, Russia, by U. S. Department of Agriculture	95	40	S. beard.	2	3	85	58½	29.8

Table I.—Varieties of Wheat– Crop of 1901.—Continued.

Bulletin Number	Variety	Class	Where From	Days Maturing	Length of Stem—Inches	Bearded, Smooth, or Velvety Chaff	Length of Heads—Inches	Grain			
								Grade *	Hard Wheat—Per Cent	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
275	Pellissier, U. S., No. 1584	Macaroni..	Algeria, by U. S. Department of Agriculture	94	41	S. beard.	2½	Rej.	..	52½	19.0
276	Medeah, U. S., No. 1381	Macaroni..	Algeria, by U. S. Department of Agriculture	95	40	S. beard.	2	3	65	57	24.9
277	Yellow Gharnovka, U. S., No. 1444	Macaroni .	Ambrocievka, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	2	80	61¾	30.8
278	Gharnovka, U. S., No. 1443	Macaroni..	Ambrocievka, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	3	80	60½	31.4
279	Black Don, U. S., No. 1446	Macaroni..	Ambrocievka, Russia, by U. S. Department of Agriculture	94	39	V. beard.	2	3	75	57½	25.9
280	Gharnovka, U. S., No. 1447	Macaroni..	Taganrog, Russia, by U. S. Department of Agriculture	94	40	S. beard.	2	2	85	61	32.4
281	Beloturka, U. S., No. 1520	Macaroni..	Russia, by France, by U. S. Department of Agriculture	94	42	S. beard.	2	2	75	62	32.6
282	Kubanka, U. S., No. 1440	Macaroni..	Uralsk, T. Russia, by U. S. Department of Agriculture	94	40	S. beard.	1¾	2	70	61	32.5
283	Velvet Don, U. S., No. 1445	Macaroni..	Ambrocievka, by U. S. Department of Agriculture	94	41	V. Beard.	2	3	80	60	29.6
284	Polish, U. S., No. 1565	Flint	France, by U. S. Department of Agriculture	98	42	S beard.	4	2	85	57¼	21.9

* Macaroni varieties have no milling grade.

Table II.—Five Varieties of Wheat in Each Class, viz.: Macaroni, Fife and Blue Stem, Giving Largest Yields in 1901.

Bulletin No.	Variety	Class	Grade	Hard Wheat—Per Cent	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
268	Aronautka	Macaroni	2	90	62	34.0
271	Novorossisk	Macaroni	2	90	61½	33.4
269	Wild Goose	Macaroni	2	90	62	33.1
281	Beloturka	Macaroni	2	75	62	32.6
282	Kubanka	Macaroni	2	70	61	32.5
267	American	Blue Stem	2 N	95	59	30.5
266	Selected Haynes'	Blue Stem	2 N	95	59½	30.2
264	Haynes'	Blue Stem	2 N	96	59¼	29.7
265	Bolton's	Blue Stem	2 N	95	59	29.7
263	Marvel	Blue Stem	2 N	95	58	28.4
257	Minnesota, No. 285	Fife	3 N	95	60	29.9
253	Saskatchewan	Fife	2 N	90	58¼	27.2
252	Selected McKendry's	Fife	2 N	95	58½	27.1
261	Experiment Station 66	Fife	3 N	95	57	27.0
254	Pillsbury	Fife	3 N	90	58	26.9

In yielding qualities aronautka macaroni wheat stands at the head in this trial. The seed of this wheat was obtained from T. N. Oium, Lisbon, North Dakota. The wheat has been grown in Ransom county for eight years, and the original seed is said to have been brought from Canada. The variety has been thoroughly acclimated and adapted to North Dakota soil and conditions. Several of the macaroni sorts received from the United States department of agriculture yielded nearly as well as aronautka, and the wild goose wheat from Wm. Rennie, Toronto, Canada, is also an excellent variety of the macaroni type.

In the blue stem class, American blue stem from Wm. Rennie, Toronto, Canada, gave the largest yield, which was closely seconded by Selected Haynes' blue stem, a strain of Haynes' blue stem, which has been bred up by selection at the Minnesota station. The original Haynes' blue stem is still being grown for seed by L. H. Haynes, Fargo, North Dakota. The original seed of Bolton's blue stem came from Thomas Bolton, Park River, North Dakota. This is also an excellent strain of blue stem wheat.

The best producing fife variety, Minnesota No. 285, is one of Professor Hays' selected and improved varieties. It is a coarse, large headed variety, with smooth but slightly bearded chaff, and the grain appears to be of good quality, while the variety is also an excellent producer. As an average for eight years' trials, the yields of the best producing fifes and the best producing blue stems stand as follows:

Blue Stem .....24.9 bushels per acre
Fife .....24.0 bushels per acre

As regards grade, the fife has averaged a little less than one grade better than the blue stem.

Comparing the average yield of the five best producing varieties in each class for the year 1901 gives the following:

Class	Yield Per Acre—Bushels	Difference—Bushels
Macaroni	33.1	
Blue Stem	29.7	3.4
Fife	27.6	5.5
Blue Stem and Fife	28.6	4.5

The macaroni sorts yielded 3.4 bushels per acre more than the blue stem and 5.5 bushels more than the fife, or 4.5 bushels more than the average of the fife and blue stem varieties taken together.

Macaroni wheat has been grown at this station for three seasons. The yields of macaroni as compared with the best producing fife and blue stem varieties for the three crops is given below:

Crop	Yield Per Acre		Difference—Bushels
	Macaroni—Bushels	Fife and Blue Stem—Bushels	
1899	34.9	26.6	8.3
1900	20.5	23.6	-3.1
1901	33.1	28.6	4.5
Average	29.5	26.3	3.2

The macaroni wheat has outyielded the other sorts two years out of the three. In the dry season of 1900, the macaroni wheat made a thrifty growth and filled well, but was thin on ground. The kernels of macaroni wheat are generally larger than those of fife or blue stem, and in order to get an equal number of these larger kernels in the ground, the drill should be opened to sow about a peck more per acre than is ordinarily sown of fife or blue stem. It appears also that macaroni wheat stools less than other wheat, and the experience at this station indicates that it should be sown a little thicker for this reason. If the drill is set to sow one and one-half bushels of wheat per acre, macaroni wheat will scarcely stand too thick, even in the most favorable seasons.

Reports from the South Dakota experiment station and from points west of the Red River Valley in North Dakota indicate that a greater difference in yield in favor of the macaroni wheat is to be expected there.

There seems to be ample demand for this wheat by macaroni manufacturing establishments in this country, as they now import large quantities of it. It was purchased at the price of No. 2 Northern wheat during the past season.

The following letter from the Van Dusen Harrington company, of Minneapolis, bearing the date of Nov. 15, 1901, indicates the views of that firm relating to the market demand for macaroni wheat:

Replying to your valued favor of the 14th would state so far we have purchased all of the offerings in this market of the macaroni wheat. The receipts have been very light at the present time on account of the weather and also for the reason that quite a percentage of the present crop is being held for seeding purposes. So far as we are able to ascertain there will be a continued good demand for this wheat.

Yours truly,

(Signed.) THE VAN DUSEN HARRINGTON CO.

A good quality of bread can be made from flour milled from

macaroni wheat, but the fact that bread and flour from macaroni wheat is yellow or dark in color causes it to have much less value upon the general market.

It requires some special skill to grind it also, which causes most millers and elevator firms to refuse to handle it for flour production.

The better strains of macaroni wheat while resembling the wild goose strain differ from it considerably and are less flinty and more like the bread wheats.

AMOUNT OF SEED WHEAT TO SOW.

The experiment of seeding wheat at different thicknesses was continued during season of 1901. The trial was made on fall plowed land, which grew a crop of wheat in 1900 and corn in 1899. Selected Minnesota No. 163 was the seed used in this trial. The plots were seeded May 7th with a Dowagiac shoe-chain drill. The thickness of seeding trials was begun with this drill, and it has been used in all succeeding trials in order that the results from year to year may be comparable.

No regularly marked difference was observed in the time of ripening of the 1901 crop. The thinnest sown wheat showed a good stand. The straw averaged about thirty-six inches in height on all of the plots, and the heads were of good length, but not very well filled. Close observations revealed the fact that the straw was thicker and more inclined to crinkle at the bottom on the thicker sown plots. The grain on all the plots was ripe and harvested August 8th.

Table III gives the results of the trial, and includes the average yield for all trials which have been made at this station.

TABLE III.—AMOUNT OF SEED WHEAT PER ACRE.

Plot Number	Seed Sown Per Acre—Pecks	Crop of 1901					Average for 1898, 1899, 1900 and 1901	Average for Eight Trials
		Stand	Grade	Hard Wheat—Per Cent	Weight Per Bushel—Lbs.	Yield Per Acre—Bushels	Yield Per Acre—Bushels	Yield Per Acre—Bushels
1	3	Good	2 N.	95	59½	18.7		
2	4	Very good	2 N.	95	58¼	20.6	24.0	18.6
3	4½	Very good	2 N.	95	60	21.2	24.0	19.5
4	5	Quite thick	2 N.	95	60	21.4	24.2	19.4
5	5½	Thick	2 N.	95	59	21.6	24.8	20.3
6	6	Thick	2 N.	95	59½	21.0	25.6	19.9
7	7	Very thick	2 N.	95	60½	21.0	25.8	
8	8	Very thick	2 N.	95	59¼	20.0		

As an average for the four trials six and seven pecks of seed wheat per acre have given the largest average yield. This average includes the crop of the dry season of 1900, in which the increased yeld from the thick seeding was very marked. In the 1901 trial and as an average for eight trials, five and one-half pecks of seed has produced the largest yield of wheat.

VARIETIES OF OATS.

Twenty-six varieties of oats were grown in the field trial in 1901. Nearly all of these were new varieties secured from various seedsmen and grown at this station for the first time last season. A few were new seed of some of the old varieties which have been reported upon in Bulletin No. 39, and in the eleventh annual report of this station.

The oats were sown upon fall plowed land which grew wheat in 1900 and corn in 1899. The field was prepared with the Acme harrow and seeded on May 3rd and 4th at the rate of two bushels of oats per acre. The oats came up well, stooled heavily and made a good stand on all the plots. On those plots which gave the largest yields, the stand was noted as being "excellent" and "thick." The oats were not injured much by the wet weather. All varieties were attacked by rust, but not enough to seriously damage the crop. Black oats seem as a rule to rust worse than white ones, and late oats are perhaps more often injured by rust than are early varieties. Varieties which have a medium season are usually least affected by rust and adverse conditions.

Because of the heavy growth of straw the oats lodged some on nearly all of the plots. Nos. 84, 105 and 106 did not lodge. Nos. 85, 95, 100, 103 and 104 lodged 10 to 20 per cent. Nos. 99 and 101 lodged 60 per cent. No. 86 lodged 50 per cent, and the other varieties were noted as being lodged from 30 to 40 per cent. No. 80 (sixty day oats) was harvested July 22nd, eighty days after planting. The regular harvest began July 31st and was completed August 10th. The oats were thrashed in good condition from the shock during the last week in August. Table IV gives the results of the trial.

Table IV.—Varieties of Oats—Crop of 1901.

Bulletin Number	Variety	Where From	Days Maturing	Length of Straw—Inches	Form of Heads	Length of Heads—Inches	Color of Berry	Size of Berry	Shape of Berry	Weight Per Bushel Pounds	Yield Per Acre—Bushels
81	Racehorse	*Missouri Exp. Station	96	45	Side	11	White	Medium	Medium long	34	43.3
82	American White Banner	*Missouri Exp. Station	91	41	Wh'l'd	9½	White	Medium large	Medium long	34	55.2
83	Tartarian	*Missouri Exp. Station	98	44	Side	11	White	Medium large	Medium long	34¼	43.9
84	Sixty Day, U. S., No. 5938	Russia, by U. S. Department of Agriculture	80	32	Wh'l'd	5½	Yellow	Medium small	Slender	32	50.4
85	Silver Mine	John A. Salzer Seed Co.	91	40	Wh'l'd	7	White	Medium large	Medium	36¼	60.9
86	White Bonanza	John A. Salzer Seed Co.	90	42	Wh'l'd	8	White	Medium	Short and plump	36¾	57.0
87	Big Four	John A. Salzer Seed Co.	89	40	Wh'l'd	7	Yellowish	Medium	Medium short	37½	58.8
88	Great Northern	John A. Salzer Seed Co.	90	43	Wh'l'd	9	White	Medium large	Medium long	36	56.0
89	Bow of Promise	John A. Salzer Seed Co.	89	42	Wh'l'd	8	White	Medium	Short	36	60.3
90	Bucktu's Illinois	H. W. Bucktu, Rockford, Ill.	95	50	Side	9	White	Medium large	Medium long	34	45.5
91	Quaker	H. W. Bucktu, Rockford, Ill.	93	48	Side	10	White	Medium large	Medium long	34¼	48.5
92	Sunol	H. W. Bucktu, Rockford, Ill.	93	46	Side	10	White	Medium large	Medium long	31	45.0
93	Lincoln	Oscar H. Will & Co.	92	43	Wh'l'd	8	White	Medium large	Medium long	35½	57.5
94	Minnesota, No. 26, Early Gothland	Minnesota Exp. Station	90	41	Wh'l'd	8½	White	Medium	Medium long	35½	60.5
95	Minnesota No. 6, Imp. Ligowa	Minnesota Exp. Station	89	40	Wh'l'd	7	White	Medium	Short	36½	54.9
96	Minnesota, No. 32, White Wonder	Minnesota Exp. Station	90	42	Wh'l'd	10	Yellowish	Medium	Medium	32½	59.4
97	Minnesota, No. 103	Minnesota Exp. Station	91	42	Wh'l'd	10	White	Medium small	Short and slender	35¾	59.4
98	Minnesota No. 202	Minnesota Exp. Station	92	45	Wh'l'd	10	Light yellow	Medium small	Short and slender	35½	67.1
99	Moli's New Black Beauty	Northrup, King & Co.	95	44	Side	9	Brown	Medium	Medium	29	42.2
100	Siberian White	Wm. Rennie, Toronto	90	42	Wh'l'd	9	White	Medium large	Medium long	37¾	60.5
101	Black Tartarian	Wm. Rennie, Toronto	94	52	Side	10	Brown	Medium large	Long	28	39.8
102	Abundance	Wm. Rennie, Toronto	91	44	Wh'l'd	9	White	Medium large	Medium long	35	59.0
103	Ligowa	Wm. Rennie, Toronto	90	41	Wh'l'd	7	White	Medium	Short and plump	38	58.4
104	New Zealand	Wm. Rennie, Toronto	97	50	Side	9	White	Medium large	Short	37½	49.9
105	New Danish White	Wm. Rennie, Toronto	90	38	Wh'l'd	8	White	Large	Medium long	37¼	54.0
106	Egyptian	Wm. Rennie, Toronto	91	39	Side	7	White	Medium small	Short and plump	37½	50.9

* The original seed of these varieties was grown at the North Dakota station.

TABLE V.—VARIETIES OF OATS GIVING LARGEST YIELDS IN 1901.

Bulletin Number	Variety	Yield Per Acre—Bushels	Weight Per Bushel—Pounds	Harvest Season
98	Minnesota, No. 202	67.1	35½	Medium
85	Silver Mine	60.9	36¼	Medium
94	Early Gothland	60.5	35½	Medium early
100	Siberian White	60.5	37¾	Medium early
89	Bow of Promise	60.3	36	Medium early
96	White Wonder	59.4	32½	Medium early
97	Minnesota, No. 103	59.4	35¾	Medium
102	Abundance	59.0	35	Medium
87	Big Four	58.8	37½	Medium early
103	Ligowa	58.4	38	Medium early
93	Lincoln	57.5	35½	Medium
86	White Bonanza	57.0	36¾	Medium early
88	Great Northern	56.0	36	Medium early
82	American White Banner	55.2	34	Medium

The harvest season of the varieties mentioned in the above table is denoted as "medium" and "medium early." As a matter of fact, there was not more than three days difference in the ripening periods of any of the varieties named. Only one very early variety (No. 84), was grown in the trial last season. The late maturing sorts did not yield well, and are not included in the list of varieties giving largest yields. In the dry season of 1900, the "late" and "medum late" varieties outyielded the earlier sorts.

No. 98, which gave the largest yield in the 1901 trial is one of Professor Hays' selected varieties and was grown at this station for the first time last season. Silver Mine oats which gave the next highest yield has been tested at this station for three successive seasons, 1899, 1900 and 1901. In 1899 this variety stood at the head of the list in yielding qualities, but in the dry season of 1900, it fell below some of the varieties in its own class. Early Gothland has been tested at this station for several seasons and has proved to be one of the best yielding varieties. It is also excellent in appearance and quality of grain. Siberian White and Bow of Promise appear to be excellent yielders, and the grain of each is extra fine in appearance and quality.

VARIETIES OF BARLEY.

Fifteen varieties of barley were tested in the field trial in 1901. The ground upon which the trial was made had been farmed in the same manner and was prepared as already described for varieties of oats. All the plots were seeded May 4th at the rate of two bushels of grain per acre. The early growth was excellent and the yield proved to be very good except for the late maturing sorts. These made a poor and irregular growth of straw and did not head or fill well, and they did not ripen naturally. The

medium early sorts made an excellent stand and an even growth with large well filled heads. All varieties showed a trace of rust, but not enough to do much harm. Harvest began July 18th and was finished August 2nd. The grain was thrashed from the shock August 3rd.

Table VI gives the data secured in this trial.

Table VI.—Varieties of Barley—Crop of 1901.

Bulletin No.	Variety	Where From	Days Maturing	Length of Straw—Inches	Length of Head—Inches	No. of Rows Per Head	Length of Beards—Inches	Size of Berry	Color of Berry	Weight Per Bu.—Pounds	Yield Per Acre—Bushels
43	Moravian, U. S. No. 5793	Hungary, by U. S. Dept. of Agriculture	78	31	3	2	4	Medium large	Bronze	46	34.1
44	Silver King	Salzer Seed Co.	77	33	2 3/4	6	3 1/2	Medium	Yellow	46	38.3
45	Great Beardless	Salzer Seed Co	77	34	2 1/4	6	...	Medium large	Yellow	44 1/2	34.4
46	White Hulless	Salzer Seed Co	77	28	2	6	...	Medium	Brown	56	21.2
47	Minnesota, No. 6, Mansury	Minnesota Exp. Station	78	36	3	6	3	Medium large	Yellow	46	42.1
48	Minnesota, No. 32	Minnesota Exp. Station	78	36	3	6	3	Medium large	Yellow	46 1/2	40.0
49	Minnesota, No. 28, Barnard's	Minnesota Exp. Station	77	31	2 3/4	6	4	Medium	Yellow	48	37.6
50	Minnesota, No. 87	Minnesota Exp. Station	77	37	3	6	3	Medium	Yellow	46 3/4	40.4
51	Minnesota, No. 100, Houston's Golden Queen	Minnesota Exp. Station	75	30	2 1/8	6	4 1/2	Medium	White	46	30.6
52	Minnesota, No. 105	Minnesota Exp. Station	77	33	2 7/8	6	3 1/2	Medium	Yellow	46	40.3
53	Highland Chief	Northrup, King & Co.	88	30	3 to 4	2	5	Large	Bronze	49	25.3
54	New White Hulless	Northrup, King & Co.	75	24	2 1/8	6	..	Medium	Brown	57 1/2	22.3
55	Mandscheuri, six-rowed	Wm. Rennie, Toronto	78	34	3	6	3 1/2	Medium large	Yellow	45	45.1
19	Success	Minnesota Exp. Station	90	26	3 1/2	2	4	Large	Light yellow	47 3/4	34.8
21	McEwan's Hulless	Park River, N. D.	75	20	3	2	5	Very large	Brown	56 1/2	32.9

TABLE VII.—VARIETIES OF BARLEY GIVING LARGEST YIELDS IN 1901.

Bulletin Number	Variety	Weight Per Bushel—Pounds	Yield Per Acre—Bushels	Harvest Season
55.....	Mandscheuri	45	45.1	.Medium early
47.....	Mansury	46	42.1	.Medium early
50.....	Minnesota, No. 87.....	46.75	40.4	.Medium early
52.....	Minnesota No. 105.....	46	40.3	.Medium early
48.....	Minnesota No. 32.....	46.5	40.0	.Medium early
44.....	Silver King.....	46	38.3	.Medium early
49.....	Bernard's.....	48	37.6	.Medium early

In the dry season of 1900, the late maturing varieties of oats and barley yielded much better than the early varieties. In 1901 the late maturing sorts did not yield so well as those which ripened medium early. No. 98 oats (see table IV), which has a medium ripening season gave the largest yield procured in 1901, 67.1 bushels per acre, while Mandscheuri barley, which produced the largest yield of that grain, matures medium early. The results of eight years' trials at this station indicate that with both oats and barley, the varieties which have a "medium" season inclining perhaps to "medium early," have given the largest average yields.

Mandscheuri and Mansury barley mentioned above are doubtless the same variety. The name is spelled differently but pronounced the same in each case and the varieties are alike in every respect. In eight years' trials at this station the Mansury six-rowed barley has proven to be one of the best producing sorts.

*EMMER.

Only two varieties of emmer were grown at this station in 1901. The ground had the same preparation as for varieties of barley. The drill was set to sow two and one-half bushels of barley per acre. At this rate it sowed about two bushels of emmer. In the wet season of 1901 this proved to be thick enough. Usually, however, nine to ten pecks of seed per acre would not be too much. The grain was sown May 4th, came up well and made a good stand. The straw reached a height of thirty-eight inches and carried heads two inches long and well filled. The crop from the home grown seed was ripe August 2nd, ninety days after planting. The United States variety ripened a day later. The grain

*This grain is commonly but erroneously called spelt, and is so called in previous publications by this station.

was thrashed from the shock August 23rd. The tabular statement below gives the yield and weight per bushel.

Variety	Yield Per Acre	Weight Per Bushel
Bulletin No. 2, Dakota grown seed.....	48.7	38½
Bulletin No. 5, seed from U. S. Dept. of Agriculture.....	56.0	37¼

The above yield is calculated on the basis of forty-eight pounds per bushel. Section 1722 of the laws of North Dakota, as revised by the seventh legislative assembly gives the legal weight of a bushel of spelt as forty-eight pounds.

In the report given above the United States department of agriculture seed gave the greater yield of grain per acre, although the weight per bushel was somewhat less. In former publications by this station, emmer has been discussed under the name of "spelt." It is also commonly called "speltz" or "spiltz." It seems, however, that this is not a true spelt, (Triticum spelta), but that it is botanically known as Triticum dicoccum, the common name of which is emmer, a word of German origin.

Emmer has been cultivated in this country at intervals, locally and experimentally, for a good many years.

Trials were made, according to Wallace's Farmer, about twelve years ago in growing and feeding emmer in Canada. It was later generally discarded as not being the equal of barley and oats for feeding purposes. The special attention given this cereal in recent years is due to its introduction into the Dakotas from Russia, by the German-Russian farmers, and to the fact that the United States department of agriculture has introduced and distributed among the experiment stations and throughout the northwest, some of the best Russian seed.

Emmer is grown in Servia, Germany, Russia, Spain and Abyssinia, and to some extent in France and Italy. Russia produces 16,000,000 bushels annually. All the best seed is obtained from that country and when grown in the northwest, it yields a grain equal in quality to that of the original seed. The grain is said to have been introduced into this state by Russian settlers living in McIntosh county. The station first secured seed from Mr. Geo. A. Welsh, Bismarck, N. D., in 1897.

The season of 1897 was very unfavorable on account of heavy rains and flooding of the plots. Under these adverse conditions, emmer yielded 934 pounds per acre, about 29.2 bushels at the rate of thirty-two pounds per bushel, while barley, which grew on an adjacent plot, made a complete failure.

The yield of emmer as compared with barley, oats and wheat

in a four years trial at this station (1898-1901 inclusive) is shown in the following table:

Kind of Grain	Yield Per Acre				
	1898—Pounds	1899—Pounds	1900—Pounds	1901—Pounds	Average—Pounds
Emmer	2,338	2,291	980	2,516	2,031
Barley	2,326	2,360	844	1,946	1,869
Oats	2,400	2,436	1,058	1,933	1,957
Wheat	2,212	1,552	1,397	1,719	1,720

In the above comparison, the average yield of the best producing varieties of wheat, oats and barley and the yield secured from the best producing emmer are compared. The weights are those taken as the grain came from the separator. It will be seen from this table that Emmer has outyielded wheat each season, barley every season but one, and oats two seasons out of the four. As an average for the four trials, emmer has yielded 311 pounds per acre more than wheat, 162 pounds more than barley and 78 pounds more than oats.

The general report of farmers throughout the state, who have grown emmer, is that it is a heavy yielder and very resistent to drouth. At the South Dakota station, and throughout that state, there are favorable reports as to the yielding qualities of this grain compared to barley and oats.

The grain as it is thrashed weighs from thirty-eight to forty pounds per bushel, or about the same as good oats. Botanically, emmer is closely related to wheat. The heads are two-rowed and bearded. The spikelets contain two grains each. The husk or chaff usually adheres to the kernels in thrashing, but when the hulls are removed, the grain very much resembles certain types of Goose wheat, and has the same hard flinty character. By actual trial at this station, it was found that by freight about 20 per cent of the unhulled emmer was chaff, and 80 per cent grain.

Feeding Value. In Bulletin No. 39 of this station, Professor E. F. Ladd reports the results of a chemical analysis of emmer as follows:

Constituents	Emmer Not Hulled—Per Cent	Hulled Grain—Per Cent	Hulls Alone—Per Cent
Water	8.88	10.03	4.62
Ash	4.33	1.84	13.58
Fat	2.55	2.80	1.64
Protein	9.81	11.69	2.81
Crude fiber	10.09	2.94	36.68
Carbohydrates	64.34	70.70	40.67
Totals	100.00	100.00	100.00

The small amount of protein or muscle forming material and the high percentage of ash and crude fiber in the hulls indicate that their actual food value is small. As a coarse food to dilute the rich grain and cause it to be better masticated and digested by stock, the hulls are doubtless of much value. The composition of emmer both hulled and unrulled is compared with that of wheat, oats and barley in the following table:

Constituents	Emmer Whole—Per Cent	Barley—Per Cent	Oats—Per Cent	Wheat—Per Cent	Hulled Emmer—Per Cent
Water	8.88	10.9	11.0	10.5	10.03
Ash	4.33	2.4	3.0	1.8	1.84
Fat	2.55	1.8	5.0	2.1	2.80
Protein	9.81	12.4	11.8	11.9	11.69
Crude fiber	10.09	2.7	9.5	1.8	2.94
Carbohydrates	64.34	69.8	59.7	71.9	70.70
Totals	100.00	100.00	100.00	100.00	100.00

This comparison shows that hulled emmer is very similar in composition to wheat. The percentage of digestible nutrients has not yet been determined, but the composition of the unhulled emmer, which is the natural condition of the grain, indicates that its feeding value should be a little less than that of barley or oats.

No extended trials in feeding emmer have been conducted at this station. The grain has been fed whole to horses, sheep and hogs, usually mixed with, or alternating with other grain. The stock do not seem to eat it with a relish when fed in this way.

The South Dokota station in Bulletin No. 71 reports the results of a feeding trial in which emmer and barley were fed whole, each as a single grain ration, to fattening sheep. During a period of fifteen weeks, the lot of sheep fed barley gained one and one-half times as much as the lot fed emmer. It took 7.47 pounds of Emmer to produce a pound of gain, and 5.09 pounds of barley. The lot of twelve sheep fed emmer consumed 2,244 pounds of that grain in the fifteen weeks, while the other lot of twelve sheep consumed 2,318 pounds of barley.

It was concluded from this experiment that emmer is worth about two-thirds as much as barley for feeding to fattening lambs, as a single grain ration, and that about twice the profit can be realized from fatttening sheep upon barley as can be obtained from feeding Emmer. The results obtained in this experiment apply to these grains only when fed as a single grain ration and fed whole, and should not be used without modification in determining the value of them when used as a part of the ration, to-

gether with other grains. Emmer should not be condemned as a feed until it has been thoroughly tested. Extensive trials have proven that the grain is a good producer. It seems especially adapted to the drier portions of the state. It is very hardy and resists the attacks of rust and smut much better than the common cereals. It is easy to cultivate, requiring about the same methods of culture as are used in growing barley and oats. Emmer should be drilled at about the same rate per acre as oats, and sown early, preferably upon fall plowed land.

FLAX EXPERIMENTS.

No regular variety test of flax was made in 1901. A sample of Argentine flax (seed secured from Magill & Co., Fargo) was sown along side of common flax, both on old land and upon timothy sod. The Argentine flax was thinner, more weedy and did not make so good a growth as the common flax. The actual comparative yields were not determined, but it was estimated that the common flax was at least one-fourth better crop than the Argentine flax.

Quantity of Flax to Sow. The experiment in sowing flax at different thicknesses was continued in 1901. The ground used for the trial produced a crop of millet in 1900, was fall plowed and kept cultivated in the spring until the flax was seeded, May 18th. The flax came up well and made a good stand on all plots and was not weedy. The flax was harvested August 17th. There was little difference in the ripening period. The flax did not ripen evenly, however, and there were many green bolls when it was cut, which injured the quality of the seed.

Table IX gives the data secured and represents the average yields for two crops, 1900 and 1901.

MILLET.

The trial of varieties of millet was a partial failure last season due to deep planting and to adverse weather conditions. At the time of seeding, June 3rd, the surface soil (fall plowing) was quite dry and loose and the seed was sown two to three inches deep. Almost immediately heavy rains fell, the soil became wet and compact, and the millet failed to come up well. Several of the plots contained so little millet and so much pigeon grass that they were discarded from the trial. The varieties which made such a poor stand that they were thrown out of the trial were as follows:

Common millet, German millet (southern grown seed), and Early Fortune millet, from Northrup, King & Co., Earliest Russian millet, from the Salzer Seed Co., and Broom-corn millet, from U. S. department of agriculture.

All of the varieties named in table VIII matured and were cut for seed except Buckbee's California millet, which failed to ripen seed, and was cut for hay September 16th two days before frost.

Table VIII.—Varieties of Millet—Crop of 1901.

Bulletin Number	Variety	Where From	Days Maturing	Height of Straw—Inches	Kinds of Heads	Color of Seed	Size of Seed	Weight Per Bushel—Pounds	Yield of Seed Per Acre—Bushels*	Yield of Straw Per Acre—Pounds	Total Yield Per Acre—Pounds
21	Japanese barnyard grass	U. S. Dept. of Agriculture.	93	33	Cock'sfoot. .	Light brown..	Large...	37¼	58.4	6,572	10,076
22	New Japanese.....	Northrup, King & Co.....	93	36	Cock'sfoot ..	Light brown..	Large...	38.0	47.0	6,589	9,409
24	New Siberian.....	Oscar H. Will & Co.....	90	32	Foxtail.....	Yellowish red.	Medium	55½	39.3	4,773	7,131
25	Bucktu's California....	H. W. Bucktu, Rockford, Ill.	..	40	Foxtail.....	Bright yellow.	Medium	....	....	9,766	9,766
26	Hungarian	Northrup, King & Co.....	91	34	Foxtail	Bl'k and green	Medium	50¾	34.4	5,433	7,497
27	Siberian	Northrup, King & Co.....	91	34	Foxtail.....	Yellowish red.	Medium	52½	36.0	5,488	7,648
28	Hog	Northrup, King & Co.....	90	38	Close broom	Yellow.....	Large..	58½	29.4	3,480	5,244

* Calculated at the rate of 50 pounds per bushel.

In the above trial the yields were somewhat in proportion to the stand of millet on the several plots. Japanese Barnyard Grass and New Japanese millet, which are botanically the same, viz.: Panicum crus-galli, made a very thick stand, in fact too thick for the best growth and production of seed. This grass is classed with the millets in the above trial, but it has no relation to them botanically. It belongs to the same chemical family and looks very much like the common barnyard grass of our fields, however, it appears to be a heavy yielder, both of fodder and of seed. No. 21 in the above trial yields fifty-eight bushels of seed (fifty pounds per bushel), and three and one-half tons of straw per acre. The Salzer Seed company sends this grass out under the name of "Billion Dollar Grass." A small plot of this grass (one one-hundredth of an acre) was seeded in our grass nursery in 1901, early in the season (April 26th.) It made an immense growth and when cut (August 27th) it averaged four and one-half feet in height with heads five and one-half inches long, heavily loaded with seed. The yield from this small plot was at the rate of 3,190 pounds of seed and five and one-half tons of straw per acre.

Japanese Barnyard Grass has not been tested at this station as to its feeding qualities. The fodder inclines to be coarse, but is quite leafy and stock seem to eat it fairly well. The seed is much lighter than millet seed and resembles the wild type in form and color. No experiments have been made as to its feeding value, but the large yield secured would make the crop a profitable one if the seed proves to be valuable for feeding purposes.

Buckbee's California millet which produced the largest yield of fodder, nearly five tons per acre, appears to be a strain of German millet, and made a growth similar to that obtained from southern grown seed. This variety made an excellent stand and a rank growth of fodder, but did not mature seed.

In the eleventh annual report of this station, page 78, a comparison is made of the yields of German millet from southern grown seed and North Dakota seed. As an average for two crops, 1899 and 1900, the North Dakota seed gave one and one-half tons less fodder, but over a ton more grain per acre than the southern grown seed. The total product per acre was as follows:

North Dakota seed	7,544 pounds
Southern grown seed	8,555 pounds

It was observed that the millet from southern grown seed made a heavy growth of fodder, but produced few heads and was not inclined to mature seed in this latitude. As millet becomes acclimated here it tends to mature earlier and to produce large quantities of seed.

The yield of millet seed as compared with the yield of other

grains in a three year's trial at this station (1899-1901 inclusive) is shown in the following table:

Kind of Grain	Yield Per Acre			
	1899—Pounds	1900—Pounds	1901—Pounds	Average—Pounds
Millet	2,245	2,095	1,820	2,053
*Emmer	2,291	980	2,516	1,929
Oats	2,436	1,058	1,933	1,809
Barley	2,360	844	1,946	1,717
Wheat	1,552	1,397	1,719	1,556

*This grain is commonly but erroneously called spelt.

In the above comparison the average yield of the best producing varieties in each class are compared. It will be seen from this table that millet has outyielded each of the other grains as an average for the three trials. No particular attention has been paid to the selection of varieties of millet for the purpose of seed production. From ordinary North Dakota grown seed of the German and Hog millet types, yields of forty to fifty bushels per acre are not uncommon. With the Russian Broom-corn types which are now being introduced even larger yields of seed may be secured. (See eleventh annual report of this station, page 79.)

Not only is millet very productive as a crop, but experiments have shown it to be practically equal to corn and potatoes as a rotation crop for wheat. In an eight year's trial at this station, a crop of millet every fourth year gave an average increase of five and one-third bushels per acre in the succeeding wheat crops, as compared with growing wheat continuously.

Feeding Value. No feeding trials with millet seed have been completed at this station. Several trials are contemplated and others are now under way.

Several persons in this state have reported good results from feeding millet seed meal to horses and hogs. In Feeds and Feeding, Professor Henry writes: "Millet is grown in South Europe, parts of Asia and in Africa for human as well as for animal food." In his Feeding Animals, Stewart writes: "Millet meal is a highly appropriate food for young and mature horses. It has a higher proportion of albumenoids and a higher nutritive ratio than oats, but has less oil. It is found, when well ground, (and it cannot properly be fed without grinding), to be one of the best rations for horses, being particularly adapted to the development of muscular strength."

The following table gives the quantities of digestible matter of different kinds in millet as compared with the standard feeding

grains, viz.: corn, barley and oats as given by Professor Henry in his Feeds and Feeding:

NUMBER OF POUNDS OF DIGESTIBLE MATTER IN 100 POUNDS.

Name of Feed	Dry Matter—Pounds	Digestible Nutriments in 100 Pounds		
		Protein—Pounds	Carbohydrates—Pounds.	Ether Extracts—Pounds
Corn	89.1	7.9	66.7	4.3
Barley	89.1	8.7	65.6	1.6
Oats	89.0	9.2	47.3	4.2
Millet seed	86.0	8.9	45.0	3.2

The above table indicates that millet resembles oats more closely in the amount and proportion of digestible material which it contains than it does barley or corn. It contains three and three-fifths pounds less total digestible matter per hundred pounds than oats, but while it has less total digestible protein or muscle forming material, it has a larger proportion of it or a narrower nutritive ratio.

The above data and testimony certainly warrant the belief that millet seed is a reasonably sure source of available grain food if intelligently used.

Millet seed meal forms a rather heavy or concentrated food and would be more safely fed if mixed with some coarser material like wheat bran.

Table IX.—Seed Flax—Different Amounts of Seed Per Acre—Crop of 1900

Plot Number	Seed Per Acre—P'cks	Stand	Days Maturing	Height of Straw—Inches	Weight Per Bushel—Pounds	Quality of Seed—Per Cent	Yield Per Acre		Average of Two Crops 1900 and 1901 Yield Per Acre	
							Grain—Bushels	Straw—Pounds	Grain—Bushels	Straw—Pounds
1	1½	Good	91	27	52½	85	11.9	3,227	12.4	2,425
2	2	Good	91	27	56¼	93	11.3	2,840	12.0	2,061
3	3	Excellent	91	27	53¼	92	11.8	2,701	11.0	1,955
4	4	Thick	90	26	53	90	10.5	2,580	12.1	1,971
5	5	Very thick	90	26	55	97	11.0	2,580	13.9	2,161
6	6	Very thick	91	24	52¼	90	10.7	2,420	13.1	1,882

In 1901, the thinnest seeding (one and one-half pecks per acre) produced the largest crop, both of seed and straw. The average yield from the two crops seems also on the whole to be in favor of thin seeding. The thick seeding has given the larger crop of seed as an average for the two trials, but this is due mainly to the large crop se ured from the thick seeding in the dry season of 1900, when flax came up poorly and did not branch well.

FLAX AND WHEAT MIXED.

This is the fourth season that experiments have been made by this station in sowing flax and wheat together. The results of former trials are given in the eleventh annual report, page 82. The conclusion at that time was that on ordinary farm land which is only fertile enough to produce one good crop of wheat or flax in a season, nothing is gained by attempting to produce two crops on the same ground at the same time. However, it was observed that on very rich soil where wheat is likely to grow too rank and to lodge, the two grains may be profitably grown together, the flax tending to reduce the growth of wheat and also acting as a support to prevent the grain from lodging. The trial in 1901 was a demonstration of this observation.

The 1901 trial was made upon corn land which was in excellent condition to produce a large crop of wheat. The season proved to be too wet and the wheat went largely to straw, but was less injured upon the plots upon which flax was sown with the wheat than it was where wheat was grown alone. In the 1901 experiment the wheat was sown at the rate of three and four pecks per acre, and the flax at the rate of one and one-half, two and two and one-half pecks per acre. The flax was sown three different dates, viz.: with the wheat, one week after the wheat was sown and two weeks after the wheat was sown. The wheat was drilled east and west and the flax north and south. The plan of the experiment together with the data obtained are shown in Table X.

TABLE X.—FLAX AND WHEAT—CROP OF 1901—SHOWING PLAN OF EXPERIMENTS AND RESULTS.

Plot Number	Crop	Date Sown	Rate Per Acre—Pecks	Date Ripe	Stand	Height of Straw—Inches	Yield Per Acre—Bushels	Weight Per Bu.—Pounds
1	Wheat	May 3	3	August 8..	Good	37½	18.83	61½
	Flax	May 3	1½	August 8..	35 P. C.	....	.95	52
2	Wheat	May 3	3	August 8..	Good	37½	18.00	60
	Flax	May 3	2	August 8..	30 P. C.	....	1.61	53
3	Wheat	May 3	3	August 8..	Good	38½	17.35	60½
	Flax	May 3	2½	August 8..	30 P. C.	....	1.80	52½
4	Wheat	May 3	3	August 8..	Good	36½	16.53	60½
	Flax	May 11	1½	August 8..	Slight	....	.52	
5	Wheat	May 3	3	August 8..	Good	36½	15.60	60½
	Flax	May 11	2	August 8..	Slight	....	.57	
6	Wheat	May 3	3	August 8..	Good	38½	16.48	60
	Flax	May 11	2½	August 8..	Slight	....	.71	
7	Wheat	May 3	3	August 8..	Good	37½	10.42	59½
	Flax	May 18	1½	August 8..	Trace	....	.89	51¾
8	Wheat	May 3	3	August 8..	Good	3[illegible]	11.35	59½
	Flax	May 18	2	August 8..	Trace	....	.22	
9	Wheat	May 3	3	August 8..	Good	36	12.89	59½
	Flax	May 18	2½	August 8..	Trace	....	.28	
10	Wheat	May 3	4	August 8..	Good	38	17.08	60¼
	Flax	May 3	1½	August 8..	Slight	....	.76	51
11	Wheat	May 3	4	August 8..	Good	38	17.64	61
	Flax	May 3	2	August 8..	Slight	....	1.06	
12	Wheat	May 3	4	August 8..	Good	39½	16.03	60½
	Flax	May 3	2½	August 8..	Slight	....	.95	50¾
13	Wheat	May 3	4	August 8..	Good	38	15.47	59½
	Flax	May 11	1½	August 8..	Trace	....	.43	
14	Wheat	May 3	4	August 8..	Good	30½	15.62	60½
	Flax	May 11	2	August 8..	Trace	....	.47	
15	Wheat	May 3	4	August 8..	Good	38	14.32	59½
	Flax	May 11	2½	August 8..	Trace	....	.38	
16	Wheat	May 3	4	August 8..	Good	38½	12.23	59
	Flax	May 18	1½	August 8..	Trace	....	.52	
17	Wheat	May 3	4	August 8..	Good	38	11.92	59½
	Flax	May 18	2	August 8..	Trace	....	.38	
18	Wheat	May 3	4	August 8..	Good	39	11.35	59
	Flax	May 18	2½	August 8..	Trace	....	.33	
19	Wheat	May 3	4	August 8..	Good	37½	10.37	57½
20	Wheat	May 3	4	August 8..	Good	36½	11.03	58½

Plots 19 and 20 are the check plots upon which wheat was seeded alone. Plot 20 received no cultivation after seeding, and should be used as a check on plots 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, and 15. It will be noticed that the yield was less from the check plot than from any of the others with which it is compared.

Upon the date that plots 7, 8, 9, 16, 17 and 18 were seeded to flax the wheat was up and in order to have a check upon the effect of the cultivation upon these plots, plot 19 was cultivated in like manner by passing the drill over it without seeding any flax. There is not much difference in the yield of wheat between these several plots, but the check has given the smallest yield. The yield from plot 19, which received the cultivation after the wheat was up was also a little less than that from plot 20 which received no cultivation. The largest yield of wheat alone (18.8

bushels per acre) was obtained from plot 1 upon which wheat and flax were seeded at the same date, at the rate of three pecks of wheat and one and one-half pecks of flax per acre. The largest combined yield (18 bushels of wheat and 1.6 bushels of flax per acre) was obtained from plot 2, which was seeded at the rate of three pecks of wheat and two pecks of flax per acre, on the same date.

It will be observed that the largest yields of both wheat and flax were obtained from the plots which were seeded to both grains on the same date. Where flax was seeded a week after the wheat, the yield of wheat was slightly decreased and the flax yield was very small. Where the flax was sown two weeks after the wheat, there was a large decrease in the wheat yield averaging about six bushels per acre, and the flax crop was practically nothing. The results may be summarized and grouped as follows:

Method	Yield Per Acre	
	Wheat—Bushels	Flax—Bushels
Wheat and flax sown at same date	17.5	1.22
Flax sown one week after wheat	15.7	.51
Flax sown two weeks after wheat	11.7	.43
Wheat alone, not cultivated after sowing	11.0	
Wheat alone, cultivated after sowing	10.4	

Flax sown at the same date with the wheat has caused a direct increase of six and one-half bushels of wheat per acre over wheat sown alone, and has given besides one and two-tenths bushels of flax per acre. The later sowings of flax show a decrease in the flax yield and a very marked decrease in the yield of wheat. This was not the result of injury to the wheat by cultivation, as the small difference in the yields of the two check plots shows. The large difference in yield of wheat seems to be due almost entirely to the better growth of the flax on the early sown plots. The flax helped to use the surplus moisture and retarded the growth of the wheat, causing it to fill better.

The wheat from the check plots weighed fifty-eight pounds to the bushel. That from the plots where flax and wheat were grown together had an average weight of sixty pounds per bushel. Most of the wheat from the plots upon which flax was sown was given a "line" grade of No. 3 northern by Mr. J. W. Carroll of the Fargo Roller Mills.

The wheat from the check plots graded No. 3 northern straight. The weight per bushel of the wheat grown with the flax was sufficient to cause it to grade No. 1 hard. Its appearance, however, in the opinion of Mr. Carroll, would not warrant a better grade

than the one given. The grain was somewhat shrunken and contained many blighted and discolored kernels. All of the flax seed was of good quality—better than that grown alone on adjacent plots.

In the 1901 trial, the best crop of flax and wheat together was secured when the flax and wheat were sown at the same date, at the rate of three pecks of wheat and two pecks of flax per acre. In the 1900 trials sowing on each acre, four pecks of wheat and ten days later two pecks of flax gave the largest yield, both of wheat and flax. The result of all experiments by this station indicate that where flax and wheat are sown together the flax should be sown soon after the wheat, at least before the wheat is up, in order to get the best results.

VARIETIES OF POTATOES.

Twenty-one varieties of potatoes were planted in the field trial in 1901. None of these were from seed grown at this station, but the seed was secured from the several seedsmen as noted in Table XI. The seed saved from the 1900 crop grown at this station was accidentally injured during the winter by being severely chilled in the cellar. The chilling reduced the vitality of the seed so much that with the unfavorable weather and soil conditions after planting, a very poor stand was secured, hence no yields are given for these old station grown varieties. (See eleventh annual report, page 93.)

The potatoes were planted May 28th and 29th in furrows about four inches deep and three feet and four inches apart, and in hills two feet apart. There were two hundred and ten hills in a row, and fifteen pounds of seed, cut at the rate of two to four eyes to the piece, were planted in each row, the equivalent of one row four hundred and twenty feet long, constituted a plot.

Wet weather and unfavorable conditions caused the potatoes to come up poorly with some varieties, and hindered early cultivation. During the early part of the season, the crop was very backward in growth, but later it made a large growth of vines and a good development of tubers, yielding an average crop. Frost killed the vines September 18th. The potatoes were dug October 24th, when the tubers even of the late maturing varieties generally seemed hard and ripe.

Table XI gives the results of the trial and a brief description of the several varieties tested.

The number of hills harvested is noted for each variety in this table, and the yield has been calculated according to the number of hills harvested, and not according to size of the plot planted. Thus, the poor stand of some varieties is not made to reduce their yield per acre, the yields given showing the relative yield per hill rather than the actual yield per acre from each plot.

Table XI.—Varieties of Potatoes—Crop of 1901.

Bulletin Number	Variety	Where From	Stage of Maturity at Frost, Sept. 18	No. of Hills Harv'd	Average Size of Tubers	Shape	Color	Depth of Eyes	Fingers and Toes—Per Cent	Mealiness—Per Cent	Flavor—Per Cent	Yield Per Acre—Bushels	Marketable—Per C.	Small—Per Cent	Scabby—Per Cent
80	Harvest King	Salzer Seed Co.	Green	203	M. large.	Oblong, irreg.	White	Shallow	5	85	80	164.8	54	17	29
81	Mark Hanna	Salzer Seed Co.	Green	185	Large.	Oblong, flat.	White	Shallow	....	85	75	171.6	95	15	
82	Salzer's Good Times	Salzer Seed Co.	Ripe	198	Medium.	Round.	Red	M. shallow	....	80	75	129.8	53	13	34
83	Million Dollar	Salzer Seed Co.	Green	198	M. large.	Oval.	L. russet.	Shallow	....	75	75	181.1	88	7	5
84	All the Year Round,	Salzer Seed Co.	¾ ripe	154	M. small.	Medium long	R. russet.	Shallow	5	90	90	163.6	33	13	54
85	Sunlight	Salzer Seed Co.	Half ripe	200	Medium.	Medium long	L. russet.	M. deep	2	95	90	207.5	39	30	31
86	Daughter of Rose	Salzer Seed Co.	Green	155	Large.	Oblong	R. russet.	Deep	5	88	90	199.2	54	15	31
87	Earliest Six Weeks	Wm. Rennie, Toronto	¾ ripe	188	Medium.	Oblong, oval.	R. russet.	Medium	15	90	95	138.5	63	19	18
88	Aristook Gem	Wm. Rennie, Toronto	In blossom	183	M. small.	Medium long.	White	Medium	12	90	80	162.8	47	23	30
89	Uncle Sam	Wm. Rennie. Toronto	Green	169	Medium.	Oblong, flat.	White	M. shallow	....	80	70	125.9	82	15	3
90	Rose of the North	Wm. Rennie, Toronto	N'ly green.	181	Medium.	Medium long.	R. russet.	Medium	Tr.	90	90	174.2	57	21	22
91	Vigorosa	L. L. Olds, Clinton, Wis.	Green	59	Medium.	Oblong	R. russet.	Medium	3	85	80	110.4	56	29	15
92	Sir Walter Raleigh	L. L. Olds, Clinton, Wis	Green	144	M. large.	Oblong, flat.	White	Shallow	....	75	70	116.8	89	8	33
93	Bovee	L. L. Olds, Clinton, Wis.	N'ly green.	107	Medium.	Oblong	Russet	Medium	3	95	95	132.5	71	16	13
94	Home Grown Acme	L. L. Olds, Clinton, Wis.	⅔ ripe	154	Medium.	Oblong	R. russet.	M. shallow	Tr.	90	90	84.84	53	26	21
95	Banner	L. L. Olds, Clinton, Wis.	Green	159	Medium.	Flat oval.	C. russet.	Shallow	....	75	70	97.8	88	10	2
96	Hammond's Wonderful	L. L. Olds, Clinton, Wis.	Green.	173	M. small.	Long	G. russet.	Shallow	Tr.	85	85	112.8	75	25	
97	Maule's Commercial	L. L. Olds, Clinton, Wis.	N'ly green.	119	V. large.	Oblong, flat.	R. russet.	Deep	Tr.	80	75	133.7	80	8	12
98	Livingtone	L. L. Olds, Clinton, Wis.	Green	182	M. large.	Oblong, irreg.	C. russet.	Shallow	Tr.	95	85	130.7	55	15	30
99	Carmon, No. 3	L. L. Olds, Clinton, Wis.	Green	182	Medium.	Oval.	Cream	Shallow	....	75	65	106.8	83	11	6
100	White Mammoth	L. L. Olds, Clinton, Wis.	Green	202	M. large.	Oblong	White	Medium	....	80	80	138.9	77	8	15
101	Giant Divide	L. L. Olds, Clinton, Wis.	Green	198	Medium.	Medium long	Cream	Shallow	Tr.	85	80	158.4	68	11	21

TABLE XII.—VARIETIES OF POTATOES GIVING HIGHEST YIELDS IN 1901.

Bulletin Number	Variety	Yield Per Acre—Bushels	Harvest Season
85.....	Sunlight	207.5	.Medium early
86.....	Daughter of Rose	199.2	.....Medium
83.....	Million Dollar.....	181.1	.....Late
90.....	Rose of the North.....	174.2	.....Medium
81.....	Mark Hanna.....	171.6	..... Late
80.....	Harvest King	164.8	.....Late
84.....	All the Year Round.....	163.6	.....Early
88.....	Aristook Gem.....	162.8	.....Late
101.....	Giant Divide.....	158.4	.....Late

This station is propagating a few varieties of potatoes for distribution among the farmers of this state. The station has on hand about fifty bushels each of experiment station No. 39, and experiment station No. 47. (See eleventh annual report.) Experiment station No. 39 was originally the "Early Andes," but has been grown and selected for several years at this station, and has proven to be one of the best yielding early sorts. Experiment station No. 47 was originally the "Rural New Yorker No. 2," a medium late variety, but several years selection at this station has made it earlier and of better quality than the original seed. These potatoes will be distributed in lots of from one to two bushels at the price of one dollar per bushel including sack.

J. H. SHEPPERD,
A. M. TEN EYCK.

WHEN TO PLOW FOR WHEAT.

In an eight year's trial of continuous wheat cropping, at this station, the results of plowing in the spring and fall, and at different times in the fall are shown in the following table:

SUBMARINE RESULTS OF AN EIGHT YEAR'S TRIAL, 1892-1899 INCLUSIVE.

Number of Plots in the Trial	When Plowed	Total Yield Per Acre in Eight Years—Bushels	Average Yearly Yield Per Acre—Bushels	Presence of Weeds in 1899—Per Cent
1.....	Spring.....	131.3	16.4	60
5.....	Average of all fall plowed plats.....	145.8	18.2	16
3.....	Early fall, last of September	138.1	17.3	20
1.....	* Middle fall, middle of October, clover in wheat annually.....	148.6	18.6	15
1.....	Late fall, first of November.....	150.7	18.8	5

* A little clover was seeded with the wheat each spring on this plot and was plowed down each fall. This has made the yield from middle fall plowing larger than it otherwise would have been.

In this trial fall plowing has given an average yearly yield of 1.8 bushels more wheat per acre than spring plowing, and the late fall plowing has produced larger crops on the average than the early or medium fall plowing. In the column headed "presence of weeds," it will be noticed that at the end of the experiment, in 1899, the spring plowed land has become much weedier than the fall plowed pieces. These weeds were mostly wild oats.

Below are given the results of another trial which has been conducted for five years, 1897-1901 inclusive. This trial includes forty one-fourth acre plots, twenty spring plowed and twenty fall plowed ones.

SPRING VERSUS FALL PLOWING FOR WHEAT—RESULTS OF FIVE YEARS' TRIALS, 1887-1901 INCLUSIVE.

When Plowed	Yield Per Acre					
	1897—Bushels	1898—Bushels	1899—Bushels	1900—Bushels	1901—Bushels	Average—Bushels
Spring	17.0	28.8	18.3	9.7	12.9	17.3
Fall	22.8	28.1	20.2	6.3	20.4	19.5

In the above trial as an average for five crops, the fall plowed land has yielded 2.2 bushels more per acre than the spring plowed land. It will be noticed, however, that in two years out of the five, the crop from the spring plowing was larger than that from the fall plowing.

The conclusion from the results of these trials is that fall plowing is more nearly sure to produce a good crop of wheat each year than spring plowing, and the average yield is in favor of the fall plowed land. However, from the data, it appears that about once in two or three years, spring plowing will give the larger yield, and it is hard to predict in the fall which line of plowing will produce the larger crop the next season.

Lack of time in the spring is a great incentive for plowing in the fall for wheat and other early grains. As a rule it is not advisable to fall plow for late planted crops. Stubble ground is more moist in the spring than the fall plowed land, and in a dry season like 1900, the yields are favorable to early spring plowing.

SHALLOW VERSUS DEEP PLOWING.

The following table gives the results of shallow versus deep plowing for wheat in a five years' trial, 1897 to 1901 inclusive, with fall plowing:

Year	Yield Per Acre	
	Shallow Plowing, 3 to 4 Inches Deep—Bushels	Deep Plowing, 6 to 7 Inches Deep—Bushels
1897	21.5	21.2
1898	24.1	24.5
1899	19.5	20.6
1900	5.9	7.1
1901	19.9	18.5
Average	18.2	18.4

The above trial was made upon fall plowing. Three years of the five, deep plowing gave the larger yields, but the average is only .2 of a bushel per acre in favor of deeper plowing. Throwing out the year 1901, when the shallow plowing yielded the best crop, probably by reason of the excessive rainfall, the average yields by the two methods compare as follows:

Deep plowing .....18.4 bushels per acre
Shallow plowing .....17.8 bushels per acre
Difference ..... 0.6 bushels per acre

The results do not show a strong difference of the deeper plowing, but there is sufficient difference in the crop to recommend deep in preference to shallow plowing.

An experiment upon spring plowing was carried on for three

consecutive seasons. The results are shown in the following table:

Year	Yield Per Acre	
	Shallow Plowing, 3 to 4 Inches Deep—Bushels	Deep Plowing, 6 to 7 Inches Deep—Bushels
1897	17.6	17.4
1898	26.7	29.3
1899	17.6	17.9
Average	20.6	21.5

On the spring plowing as an average for the three trials, .9 of a bushel more wheat per acre has been produced annually by the deeper plowing.

DISC VERSUS MOULDBOARD PLOWING.

The results of a three year's trial of disc versus mouldboard plowing for wheat, both in the fall and in the spring are given in the following table:

TABLE SHOWING YIELD OF WHEAT PER ACRE.

Year	Disc Plowing		Mouldboard Plowing	
	Fall—Bushels	Spring—Bushels	Fall—Bushels	Spring—Bushels
1897	24.4	16.6	21.8	17.2
1898	26.8	24.7	28.1	29.2
1899	17.2	14.9	20.5	18.1
Average	22.8	18.7	23.5	21.5

In 1897, the first year of the trial, the yield on the fall plowing from the disc plowed land was 2.6 bushels greater per acre than from the plots plowed with the mouldboard plow. On the spring plowing the yield was .6 of a bushel less per acre by the disc plowing than by the mouldboard plowing. Continuing the use of the disc plow upon the same land has produced relatively smaller yields each year, when compared to the crop from the ordinary plowing, the average decrease per acre being .7 of a bushel on the fall plowing and 2.8 bushels on the spring plowing. The first crop from the disc plowing was the only one which exceeded or equaled that from the mouldboard plowing.

In the dry season of 1900, the trial was continued upon the same plots on fall plowing. The average yield from the disc plowed land in that season was 5.5 bushels per acre, while that from the ordinary plowing 6 bushels per acre.

In the spring of 1900 a single plot was plowed with the Bradley sulky disc plow and another beside it was plowed with a mouldboard plow. Both plots had previously been plowed for three years with the Secretary disc plow, having been used in the experiment reported above. The yields from the two plots in 1900 were as follows:

Mouldboard plowing	13.2 bushels per acre
Disc plowing	12.7 bushels per acre
Difference	0.5 bushels per acre

In all of the above trials with the disc plow, except the last one given, the old John Deere Secretary disc plow was used as opposed to the John Deere Walking plow AX No. 5.

J. H. SHEPPERD,
A. M. TEN EYCK.

TRIALS WITH DIFFERENT MAKES OF DISC PLOWS.

Several disc plows have been tested on the college farm as follows:

1. John Deere Secretary disc plow.
2. Tiger disc plow, manufactured by the Stoddard Manufacturing company, Dayton, O.
3. Rock Island disc plow, manufactured by the Rock Island Plow company, Rock Island, Ill.
4. Bradley disc plow, manufactured by David Bradley Manufacturing company, Bradley, Ill.
5. Bissell rotary plow, manufactured by the Bissell Manufacturing company, South Bend, Ind.
6. Chattanooga-Hancock disc plow, manufactured by the Sattley Manufacturing company, Springfield, Ill.

The station began using the Secretary disc plow in the fall of 1897 and continued the experiment upon the same ground for three years, sowing wheat each season. The season following the first plowing, the largest crop of wheat produced was from the disc plowed ground. The next season the yield fell a little below that of the ordinary plowing, and the third season the yield averaged three to four bushels less on the disc plowed ground than from the ordinary plowing. A continuous trial has not been made with any of the other plows. I am sure, however, that nearly all of the more recent disc plows do better work than the old Secretary disc. The chief fault which I find with the old Secretary

plow is that it did not cut and turn all of the soil; it did not cover all of the stubble,, and it leaves the ground in a rough, furrowed condition.

The Tiger disc plow does better work than the old Secretary disc. It cuts nearly all that it turns, but leaves the soil in a more broken and loose condition than does the mouldboard plow. It does not cover as well as a good mouldboard plow will do. When used this plow should be followed almost immediately by a harrow or some other cultivating tool to surface and pack the soil. I have tried the gang, triple and quadruple disc plows. They are rather awkward in construction, and I do not think the draft for the width of furrow turned is much less than that of the mouldboard plow. It was observed that the draft in proportion to the width of furrow turned decreased as the number of discs was increased.

The work of the Rock Island plow was similar to that of the Tiger disc. (I used the triple disc in this trial.)

The Bradley disc plow is a neat, well made plow and easy to handle. When the soil was in good plowing condition, this plow did excellent work, practically equal to that of the mouldboard plow. I saw little difference in the draft of it, as compared with the mouldboard plow. I have used both the gang and the sulky disc and like the sulky much better than I do the gang. When the ground was in a wet condition the Bradley disc refused to turn the soil properly.

The Bissell plow is so constructed that the disc may be replaced by mouldboard bottoms. This plow is not a success either as a disc or mouldbord plow. I have tried only the gang at this station.

Late this fall I tried the Chattanooga-Hancock plow. The plow which we used was a triple disc, cutting thirty-six inches. This plow was easily drawn by four horses, while turning a furrow slice five inches thick. The ground was very wet when the plow was tried, yet the soil was turned almost perfectly and was left in even better condition than the mouldboard plow left the soil on the same day. This plow cuts off all the land that it turns. I noticed that it missed a few rose bushes, otherwise its work in cutting a smooth, clean furrow was equal to that of the mouldboard plow. The Hancock plow, like the other disc plows, leaves the ground in a more loose and broken condition than the mouldboard plow does, and should be followed by a harrow or other surfacing tool. This plow is simple in construction and is very handy in turning one way, when you are plowing around the land, but it is almost impossible to back furrow with it and make corners. The plow seems also to have less side draft than any of the other disc plows used at this station.

I am not yet ready to recommend any disc plow as preferable to the best mouldboard plows for general use on North Dakota

farms. If you have a very hard gummy soil in which it is almost impossible to keep the required depth with the mouldboard plow, the disc plow may be used very advantageously. Every large farm in North Dakota might profitably use one or more disc plows, but it would not be practicable at the present time to wholly replace the mouldboard plow by the disc plow upon any farm in North Dakota.

I do not advise farmers to purchase disc plows at the present time, except after a thorough trial on their own farms. I believe that ultimately when the disc plow has been fully perfected, that it will be a success. These plows should be tried in all parts of the state, but they should be introduced at the expense of the manufacturers and not at the expense of the farmers.

A. M. TEN EYCK.

BROME GRASS.

REPORTS FROM DIFFERENT COUNTIES IN NORTH DAKOTA AND AT THE STATION.

The county reports herewith submitted were not included in the last annual report by reason of a lack of space, but their importance as representing the results obtained with this grass during the dryest season which North Dakota has exeprienced during many years, leads me to introduce them here. In my tenth annual report I informed you that I had sent seed of this grass for trial to every county in the state. I have selected representative reports from the 100 received to show their results with it.

Following are their reports:

J. W. Foley, Medora, Billings Co., N. D.

I had no success with the brome grass seed you sent me. Very little of it came up, and what came up did not grow. I divided my seed with the neighbors, and they had no success.

Ludvig Lee, Fingal, Barnes Co., N. D.

I did not have enough to know how it will yield. I think it will make very good pasture.

L. A. Knoke, Willow City, Bottineau Co., N. D.

My brome grass seed was sown May 20, 1898. It all grew, and was about six inches high in the fall. The brome grass was two and three inches high in the spring, before the native grass had started. It was destroyed by cattle, but since it has had a chance it has done well and stands from seven to fifteen inches now (June 9, 1899), and promises a good crop.

J. O. Smith, Casselton, Cass Co., N. D.

In the spring of 1899 I sowed twelve acres of brome grass by itself, and it was good, and this year would have yielded about two tons per acre if cut for hay, but I saved it for seed. After cutting for seed it grew very thick, and made splendid pasture.

H. T. Helgesen, Milton, Cavalier Co., N. D.

I pastured two cows on two acres of brome grass, and during the drouth they just kept it even, but after the rains came, it grew as high as their knees in spite of them.

It is the best grass for pasture I ever saw.

H. S. Nichols, Oakes, Dickey Co., N. D.

I have been experimenting with brome grass for some time and I am pleased with it.

I think it is just the grass for this country. I think it will yield from one to two tons of hay per acre. It is good for pasture.

Fred H. Martin, New Rockford, Eddy Co., N. D.

I sowed the seed which I received in 1899. The first year it grew splendidly. The second year it did not grow long, but stooled out wonderfully. I do not think it has an equal for pasture. I sowed more last spring and had a good catch and it made a good growth for this year.

William Barry, Niagara, Grand Forks Co., N. D.

The excessive drouth of last summer, (1900) prevented the harvesting of any brome grass seed. I consider it an excellent grass and intend to sow all I can get next spring.

J. H. Mulroy, Hannaford, Griggs Co., N. D.

I sowed the brome grass seed which I received from you on May 29, 1899. I also sowed seven acres more which also made a good stand. I consider it a first class grass for pasture. I have about eighty bushels which I will sow next spring.

Geo. S. Roberts, Dawson, Kidder Co., N. D.

During the past year or two we have let the stock run at large, consequently the brome grass had no chance. None of our grasses grew very much last summer till after the rain came in July. I think the brome grass would be all right if it had a chance and proper attention.

C. A. Hanson, Towner, McHenry Co., N. D.

I sowed the brome grass seed you sent me according to directions. It did not do well the first year, but the second it did better. I cut it for hay, getting about two tons per acre. I then pastured it and it remained green until the frost came.

Wishek & Wilcox, McIntosh Co., N. D.

My brome grass seed was sown and came up nicely. Will report on it next year.

W. J. Graham, Walhalla, Pembina, Co., N. D.

In the spring of 1898 I sowed five pounds of brome grass seed upon the bottom land of the Pembina river. It made a moderate showing the first year and gave splendid satisfaction the second and third years. In the spring of 1899 I sowed 120 pounds on eight acres, with one bushel of barley per acre as a nurse crop. I have had splendid results from my brome grass meadow through pasturing it.

M. V. Dahl, Barton, Pierce Co., N. D.

My brome grass made a good stand, but I did not cut it. I believe it is the coming grass in the northwest.

W. E. Goozee, Devils Lake, Ramsey Co., N. D.

Last year was very unfavorable for my brome grass, it was short, but very thick on the ground. I think it will be a good grass.

W. W. McIlvain, Lisbon, Ransom Co., N. D.

I think brome grass will yield from two to two and one-half tons per acre. Much depends on the season. I think it is excellent for pasture.

Joseph Schiller, Great Bend, Richland Co., N. D.

In the spring of 1898 I sowed three pounds of brome grass seed with oats on three-eighths of an acre of good ground, it was very thin in the fall. In 1899 I harvested seventy-six pounds of good seed off of the piece. These seventy-six pounds I sowed with barley in the spring of 1900, but the season was too dry for the seed to grow. I have left it to see what it will be like next year. The piece I sowed in 1898 did not grow any seed in 1900 on account of the drouth, so I pastured it.

F. R. Miller, Grass Lake, Rolette Co., N. D.

I received one pound of brome grass [illegible] and sowed it, I have neither hay nor seed off of it, as I pasture the ground I had it sown upon. I regard it a good grass for pasture. It stays green later in the fall, and is green earlier in the spring than the prairie grass.

Carl Hamman, Richardton, Stark Co., N. D.

My brome grass seed was sown in May, 189[illegible]. It was green late in the fall, and green until summer this year, when the dry weather prevented me from getting any seed. It is a good pasture grass.

W. B. Allen, Jamestown, Stutsman Co., N. D.

I am well pleased with brome grass seed I received. It stood the drouth well last summer. I am pasturing my hogs on it and they do well.

Hugo Gailfus, Picton, Towner Co., N. D.

I sowed four acres of brome grass seed in 189[illegible]. It was very thin last spring, (1900), but it thickened up enough in the fall to cut one load off of it. My horses are very fond of it.

Chas. McKissick, Mayville, Traill Co., N. D.

My brome grass seed was sown in May, 1899. It was green late stroyed by hail this season. It was as green as could be during the dry weather, while timothy was all dried up. I think it is a good grass for pasture.

David Desautel, Grafton, Walsh Co., N. D.

I received five pounds of brome grass seed from the government in the spring of 1898 and sowed it, in 1899 I harvested twenty-one pounds of seed from five pounds.

In 1899 I bought four bushels of brome grass seed and sowed it. This year was too dry to get any seed, so I cut it in July for feed, getting two loads from four acres. I cut the second growth

in October, but the season was too wet to save it. I think brome grass will be better for pasture than for hay.
P. B. Anderson, Manfred, Wells Co., N. D.

My brome grass seed was sown on May 30, 1899. The first year it did not make much of a stand, but this year it stooled out and was quite thick. Owing to the dry season it did not grow to much height, and only part of it headed out. My opinion is that brome is the only grass for this locality.
M. L. Ayers, Dickinson, Stark Co., N. D.

I used the brome grass seed you sent me on my lawn. It makes a good lawn grass, but it is a little coarse.
T. L. Adam, New Rockford, Eddy Co., N. D.

I sowed the brome grass seed you sent me in June, 1899, with a quantity of Kentucky blue grass on my lawn. The conditions were favorable, but very little of it came up, and none of the blue grass came. After the rain the next summer (July 5th) the brome grass grew rapidly, but in patches and very uneven. It headed out very irregular and some of it was up weeks before the rest. I think it will make excellent pasture.

These reports vary somewhat, and it would be natural to expect them to do so, as they cover a limited acreage and a short period of time, but the uniformity with which they express the belief that it will prove a good pasture grass can leave little doubt of the corrections of the statement. Their reports upon its promise as a hay plant would indicate that it will prove superior to any other cultivated grass for that purpose in many districts in this state.

The following from Bulletin 45 of this station shows its value as a roughage for horses:

"The stock ate the brome hay somewhat cleaner than they did the timothy. They did exactly the same amount and kind of work and were given practically the same quantity of oats. The work done varied from plowing sixty hours a week to idleness, and averaged little over five hours per working day."

BROME HAY COMPARED WITH TIMOTHY HAY.

Feeding Oats and Timothy	Grain Pounds	Hay—Pounds	Gain or Loss—Pounds	Work—Hours
Total, 2 horses, 42 days.....	1,221.00	1,838.50	35.00	374.00
Average, 1 horse, 1 day.....	14.50	21.90	.42	5.20
Feeding Oats and Brome Hay				
Total, 2 horses, 42 days.....	1,221.00	1,863.50	65.00	374.00
Average, 1 horse, 1 day.....	14.50	22.20	.77	5.20

The experiment showed a little better results from the brome hay, but the weights did not run uniform enough to warrant a

positive decision. Other horses at the station ate thrashed brome straw with a relish. This would indicate that the straw s palatable, and that it probably contains considerable nutrition The large percentage of leaves upon it, and the number of stems which do not head out, add to the palatability and the nutrititive value of the brome hay."

It is grown under cultivation in the interior region of Russia, known as Steppes, a region which is high, dry, plains country, similar to our own, with a more rigorous climate than we have in North Dakota. It has been grown at the North Dakota experiment station for ten years and has endured our climate perfectly during that time.

Beside a long list of cultivated grasses at this station, it has proved to be the earliest to start growth in the spring, leading all others by several days. It also shows green in the spring earlier than any native of the prairie. In autumn it shows the same disposition, remaining green correspondingly later than the native and other domestic grasses.

It forms a very dense sod, more dense than any other I have ever seen. It is also a very deep rooting plant. It produces a good yield of hay upon good land, from one and a half to two tons per acre, and I have seen some fine crops of it upon sandy and gravelly soil. The hay is equal to timothy hay in quality, and is little if any harder to cure when cut.

The time of cutting it affects the quality similarly, but to a less marked degree than it does timothy. When timothy ripens its seeds the blades dry and its straw becomes harsh and woody, while brome grass leaves remain green. Brome grass cut high leaves a stubble with leaves enough to have some value for hay.

A pasture upon the station farm at Fargo which consists of eighteen acres of timothy and two acres of brome grass has been pastured with cattle regularly each season for the past five years. The cattle have eaten off the brome grass much more closely than they have the timothy each year. I have seen horses in Williams county crop it off to the ground in the month of June in preference to prairie grass, which was in good condition. In all of the above cases it should be remembered that the brome grass was offered in limited quantity and would be relished as variety, but it certainly proves that it is palatable and of good flavor. I have noticed that the brome grass remains green during dry weather when timothy dries up badly.

The price of seed is high at present, making the cost of seeding a dollar and a half to two and one-half dollars per acre. It yields a large quantity of seed and requires no extra machinery to handle it more than the grain binder and ordinary separator, followed by the fanning mill. That means, it seems to me, that as soon as the country is stocked with seed, it will cost no more

per acre to put land into brome grass than it does now to put it into timothy.

At the Assiniboia experimental farm in Canada, Superintendent Mackay reports a trial with brome grass hay for steer feeding. Two lots of three steers each were fed thrashed brome grass hay and native hay respectively, having in addition equal amounts by weight of silage, meal and bran.

While neither of the comparisons are with roughage which is commonly fed here, it gives a comparison of foods whch must mean that it is not poor in quality. These trials also indicate that thrashed brome grass hay has some value.

Brome grass sown in the spring as early as the land is in good condition has given satisfactory results generally. A good stand has also been secured by sowing the seed as late as the first of August upon land which has been cultivated during the early part of the season to prevent the growth of weeds and the loss of moisture from the ground. Upon land which does not drift, sow it without a nurse crop of any kind. Upon land which is inclined to drift seed about five pecks of oats per acre with it. The oats should be cut for hay when so used, at the time it is in blossom in order that the land may not be dried out by it. It can be sown broadcast by hand and harrowed in with a peg-toothed drag. When sown broadcast use eighteen to twenty pounds of seed per acre. Hon. J. O. Smith, of Amenia, invented an appliance, consisting of a strip of inch board three inches wide with spikes driven through it to correspond with each cup or hole in the seeder box. A short handle is placed in the middle of the strip upon the upper side. By filling the grain box half full or less with seed and agitating it with the appliance described it feeds through the drill in good form. Take the lid off the grain box and let a boy sit astride it and work the agitator. Run the drill shallow—an inch and a half or two inches deep. My observation leads me to believe that fifteen or sixteen pounds of seed per acre will be sufficient when seeded with a drill. The stand of grass during the first season usually looks very poor, insomuch that some of our farmers have plowed up fields of it at the close of the first season, believing that it had failed by reason of poor seed, or from some other cause. It will produce some late summer and fall pasture during the first season. The weeds will spring up on the land the first summer and should be mowed off once or twice to prevent too much shading and to keep the weeds from ripening. It will spread and occupy the ground in a surprising way the second spring and usually produces a good crop of hay or seed as the owner may choose. Very few weeds have an opportunity to grow with it during the second season. If the grass is cut for hay, mow it while it is in blossom. It will then make good hay and produce good aftermath or second growth for

pasture. The yield in following years will also be better than it will when the grass is allowed to ripen seed.

Supt. S. A. Bedford, of the Manitoba experiment farm, says: "In an average season it can be depended upon to produce a profitable crop of seed for two or three years, depending on the seasons, or a crop of hay for three seasons. Its limit for pasturing purposes has not yet been reached.

If the grass is cut for seed it should be harvested when the color of the seed is changing from purple to brown. If cut when the hull covering the seed is purple the seed is light and does not germinate well. If left until the seed coverings are brown, the loss from shelling is considerable. When cut for seed it is bound with the ordinary twine binder and shocked like grain until it is cured. It can then be stacked or shocked and thrashed as desired.

In thrashing it shut the wind off close or much of the seed will be blown over with the straw. Some only allow the heads of the the bundles to be knocked out by the cylinder of the separator and cast the bundle aside. That plan doubtless saves some seed, but it requires a greater outlay of labor. The seed is run through the fanning mill for a final cleaning.

Numerous trials in sowing this grass seed upon prairie sod have proven failures. It succeeds on ground which is too wet for grain, but seems somewhat less adapted to very wet ground than red top.

Regarding the growth of brome grass upon alkali land, Supt. Mackay of the Assiniboia experiment farm says:

"The brome grass on alkali land * * * was grown on two low wet spots in a field of about fifteen acres. The spots are not very large, (three quarters of an acre in both), but before sowing the bottoms were white with alkali. A good many crops have been sown on the field prior to the grass being sown, and no doubt have had some effect on the alkali. * * * The crop of hay upon the three-quarter acre was very heavy, but the land being moist would cause a good crop in any case."

Some have become alarmed by the tenacity and spreading habit of the grass and have inquired whether it can be destroyed when the owner desires to rid his field of it. If the sod is broken shallow as in breaking prairie sod as soon as the hay is taken off, and backset in early fall, it will be practically dead at the time of the backsetting, and will be in good condition for a crop of grain the following spring. If the grass is allowed to ripen seed before it is broken, it will be found much more tenacious of life and much of it will be found growing when backset.

The sod of brome grass is bound together with such a net work of roots that land which is inclined to drift is held together in a manner similar to that which is found with freshly broken prairie sod for two or more seasons.

The present obstacle to sowing brome grass extensively is the price which must be paid for seed.

When the country is once supplied, however, it will probably become as cheap per acre as timothy seed on account of the heavy yield of seed which it makes.

The seed weighs thirteen or fourteen pounds per bushel, the former weight being the one more commonly accepted.

I believe it is destined to fill a much felt want about farm and village homes in this state, where no artificial water supply can be had for watering lawn grass.

It grows thick and leafy and forms a dense tough sod, which will form a green growth of leaves when the soil is quite dry. I know of no other grass so promising for the purpose where it is not possible to water it. When sown for a lawn it should be seeded very thick. I have often thought that this grass might answer for a perennial fire break in ranch districts by remaining green during the season of the year when prairie fires run. I should expect the stock to graze it so closely that it would remain green and succulent.

J. H. SHEPPERD.

POULTRY EXPERIMENTS.

The station has winter quarters for four separate pens of poultry, and, for that reason, can do but a limited amount of experiment work with fowls.

Trap nests, after the model shown in the annual report of the Maine experiment station, for 1898, were made and successfully used in determining the number of eggs produced by each hen. The intense cold and consequent close confinement of poultry during the winter season has led me to make a comparison of the six months of warmer weather to which the heaviest of the egg laying was confined.

The thirty-one hens used in the trial were Barred Plymouth Rocks of pure breeding, and were high class fowls.

Twelve two-year-old and nineteen yearling hens were compared for egg production in this trial. The hens were in three separate apartments of the poultry house and yards, but there were yearling and two-year-old hens in each compartment, which would seem to guarantee similar conditions for the fowls upon each side of the trial.

The records for one month of seven yearling hens and of five two-year-old hens were accidentally destroyed; but, as that con-

stitutes 2.4 per cent of the old hens and 2.7 per cent of the young ones, it practically balances.

ONE AND TWO-YEAR-OLD HENS COMPARED.

	Number of Eggs Laid	
	Total in 180 Days	Average Per Hen in 180 Days
Twelve two-year-old hens	189	15.75
Nineteen one-year-old hens	939	49.42

The results above noted need little comment and indicate that it does not pay to keep two-year-old hens for egg production. The yearling hens produced an average of 49.4 eggs, while the two-year-old ones laid an average of only 15.7 eggs per head, which is a proportion of 3.3 to one in favor of the yearling hens.

The trial indicates that the poultry keeper takes little chance in sacrificing hens which are more than one-year-old each season.

BREEDING FOR EGG PRODUCTION.

There is ample opportunity to select individuals which are superior to the average as layers; and there is, also, an opportunity to select individuals which are poor egg producers, the range being from 105 eggs in 180 days to none. One-year-old hens numbers eighteen and nineteen, with records of one and nine eggs respectively as a total for six months during the laying season, indicate that, in addition to age, individuality is a matter of importance.

The six best laying one-year-old hens produced an average of eighty-three eggs during the six months, while the poorest laying six hens in the flock confined in the same quarters, and of equal age, produced twenty-three eggs, or little more than one-fourth the number laid by the six best.

The ordinary poultry grower cannot afford to take the time necessary to keep records and select the best laying hens, but I can see no reason why persons producing breeding stock cannot select their fowls upon such a basis, and the poultry grower can afford to pay a handsome dividend to breeders who will, by heredity, make hens produce even one-fourth more of eggs or of gross weight of meat from a given number of fowls without materially increasing the quantity of food required.

Twelve two-year-old hens were placed before the judge of the North Dakota and Northwestern Minnesota Poultry association, Feb. 2, 1900, when they were pullets. W. S. Russell was the expert judge who passed upon them. The following table shows how the six highest scoring hens compare with the six best lay-

ing ones which could have been selected by means of a recording nest.

LAYING RECORD OF THE SIX HIGHEST SCORING HENS.

Number of Hen	No. of Eggs Laid in 180 Days	Scored by Expert Judge	Date Hatched
206	18.0	92.0	1899
211	17.0	92.0	1899
209	12.0	91.5	1899
203	36.0	91.0	1899
205	33.0	90.5	1899
213	7.0	90.0	1899
Total for six hens	123.0	547.0	
Average per hen	20.5	91.2	

LAYING RECORD OF THE SIX BEST LAYING HENS.

Number of Hen	No. of Eggs Laid in 180 Days	Scored by Expert Judge	Date Hatched
204	36.0	91.0	1899
205	33.0	90.5	1899
208	32.0	89.0	1899
206	18.0	92.0	1899
211	17.0	92.0	1899
201	15.0	89.0	1899
Total for six hens	151.0	543.5	
Average per hen	25.2	90.6	

The above tabular statements show that the six fowls ranked highest by the judge, and which would, ordinarily, bring the highest price as fowls to breed from, produced an average of 20.5 eggs, while the six best laying hens selected from the flock laid an average of 25.2 eggs, or, practically, one-fourth more eggs. It will thus be seen that the trap hen nest offers an opportunity for breeding, egg-producing, and, hence, valuable hens much more certainly than an expert judge is able to do.

J. H. SHEPPERD.

HORSE AND CATTLE BARNS BUILT IN 1901.

After the destruction of the old college barn by fire Jan. 4, 1901, Prof. Shepperd corresponded with a number of agricultural colleges and obtained plans of their respective stock barns to aid in a suggestive way in planning the buildings to be constructed at this institution, which were two separate barns to take the place of the former combination one.

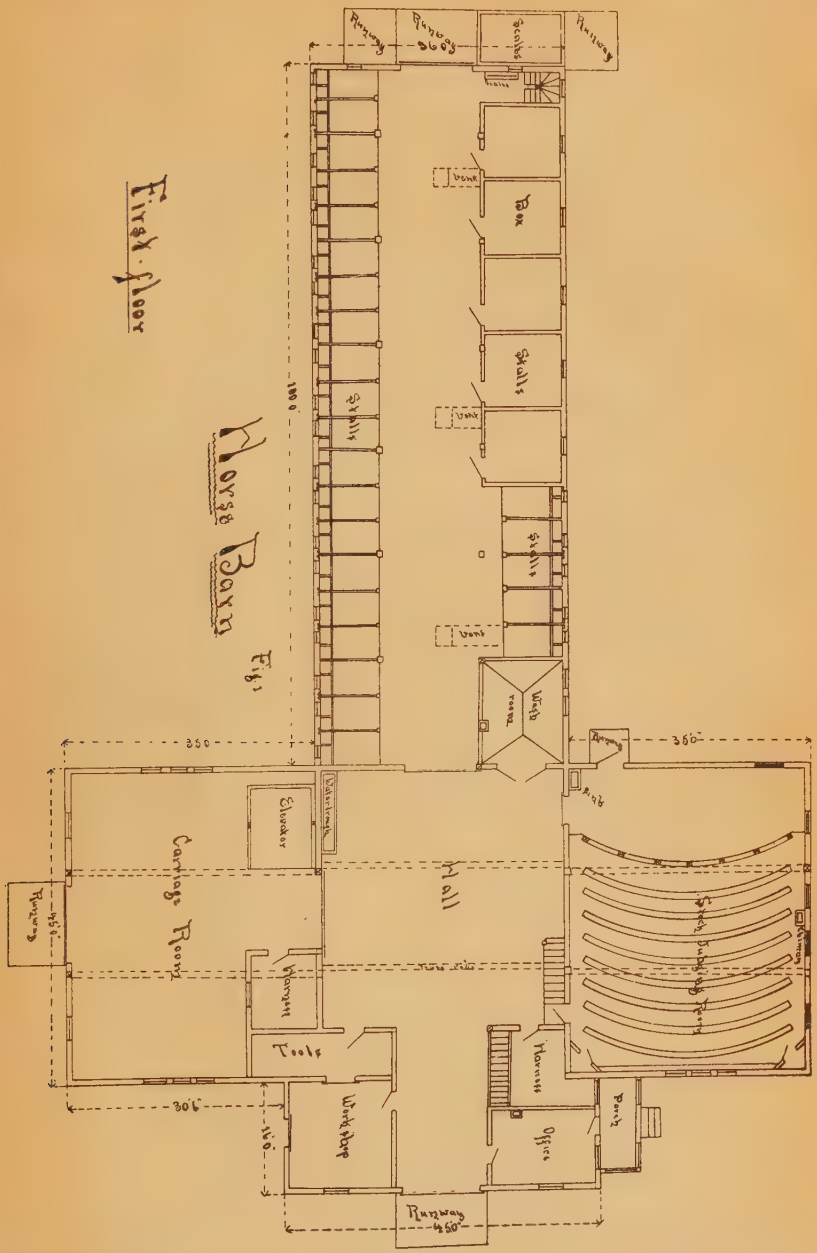
The ideas worked out by Prof. Shepperd were submitted to Hancock Bros., architects, who drew the plans and specifications for

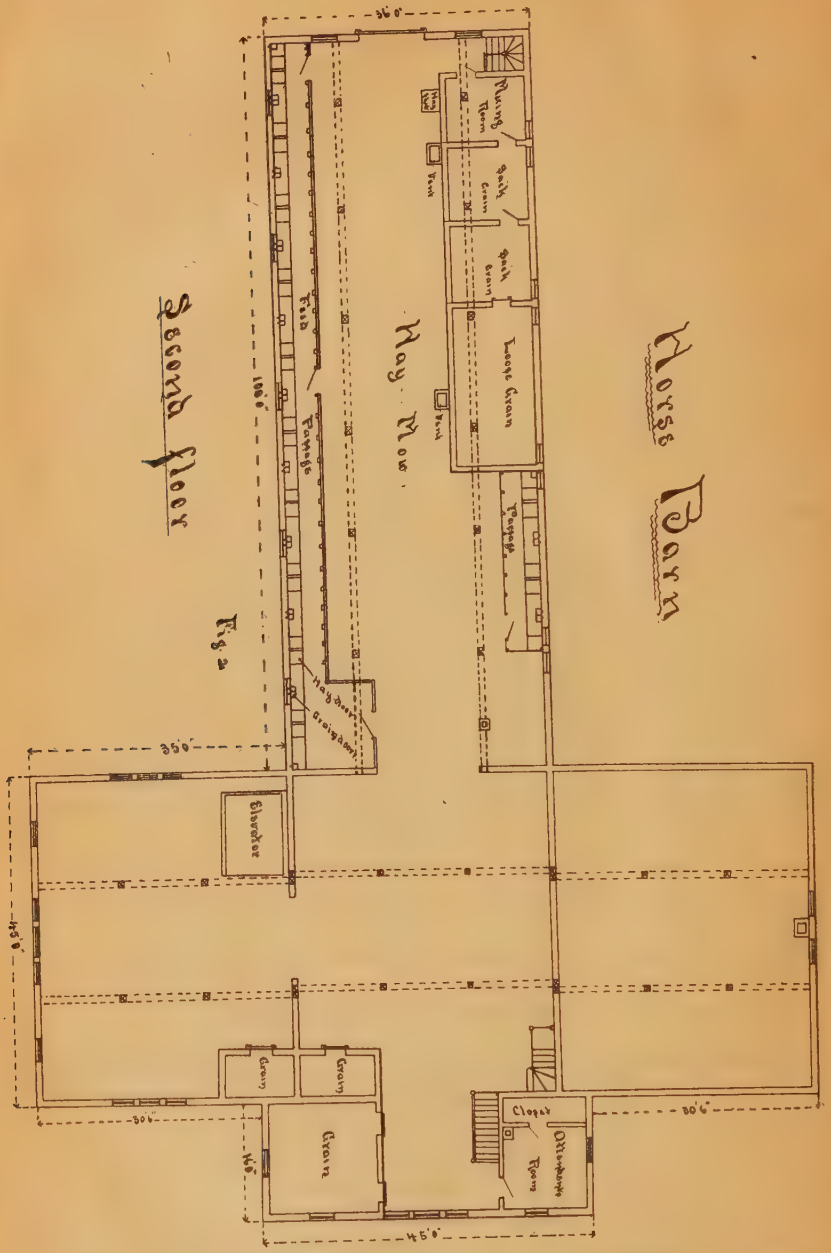
HORSE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

the barns recently completed, copies of the plans of which are submitted herewith.

The barns stand upon brick foundations; and are frame structures two stories high. They are boarded with ship lap on both sides of the studding, while the outside is covered with weather boarding. The shingles were dipped in a shingle stain before being placed on the roof, thus increasing their durability. The silo of the cow barn is built of brick, and is separate from the barn. Both barns are connected with the city water works and sewerage system.

The Horse Barn. The main part of the horse barn is forty-five feet wide and 106 feet long, with twenty feet studding. On the west of this is a small wing ten feet long and forty-five feet wide,


First floor
Horse Barn
Feb 1
Runway
Runway
Runway
Box
Stalls
Stalls
Stalls
Stalls
Box
Box
Box



PLAN OF SECOND FLOOR OF THE HORSE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

with studding of the same height as the main part. On the east is a wing which forms the horse stable proper. It is thirty-six feet wide and 100 feet long, with sixteen foot studding.

First Floor. In the south end of the main structure is the stock judging room, which is supplied with a sloping floor, a pit or arena in front large enough for five head of stock to be shown at a time in addition to leaving space enough for a veterinary operating table. It is supplied with large windows on the south and west to insure an abundance of light. The harness rooms, a large hall, and a carriage room are also located upon this floor. An elevator for conveying heavy vehicles and other articles to the upper floor is located in the carriage room, as shown in the plans submitted herewith. The west wing contains an office, a work shop, and stairs. The east wing contains twenty-five, 5ft. single stalls, the partitions between which are built of 2x8 inch planks 4 feet high, surmounted by iron bar trimmings.

The mangers are divided by the stall partitions; and in one corner of each, at the base of the grain chute, is the feed trough.

The hay racks have bar iron fronts, with chutes and covers above.

The box stalls are 11x12 feet; shiplapped on both sides, with upper and lower-half doors.

The barn is provided with a carriage wash room 12x15 feet, with a sloping floor centering towards a sewer drain. The wash-room has a chimney and is supplied with a stove. A wagon scale is located outside of the barn, as shown in this plan, with the weigh beam rising inside the building.

Three large ventilators are placed in this barn. They extend through the floor of the hay mow above the horse stable, and are provided with shutoffs.

Second Floor. (Figure 2.) On this floor are the attendant's rooms and a closet, feed bins of various kinds, a carriage and sleigh storage room, and the elevator landing, as shown in the accompanying drawings. The hay mow is directly above the horses. Along the walls of the mow is a feed passage, boarded up with ship lap, and supplied with doors leading into it at several places. In this passage are the hay and grain chutes, which enable the feeder to weigh his grain and roughage at the bins and in the mow; and to feed each a known amount without carrying the rations separately down stairs.

Two flights of stairs lead to the second floor—one landing near the attendant's room; while the other passes from the east end of the horse stable to the feed passage and grain bins on the second floor.

The floors in the offices and harness rooms are of common boards, covered with No. 1 flooring. The remainder of the first floor is laid with sized and surfaced oak planks; the floor in the single horse stalls is laid lengthwise, and has a slant of two

inches from front to back. The second floor is laid with No. 3 fir flooring throughout. The attendant's room and the office are ceiled with fir ceiling.

THE CATTLE BARN.

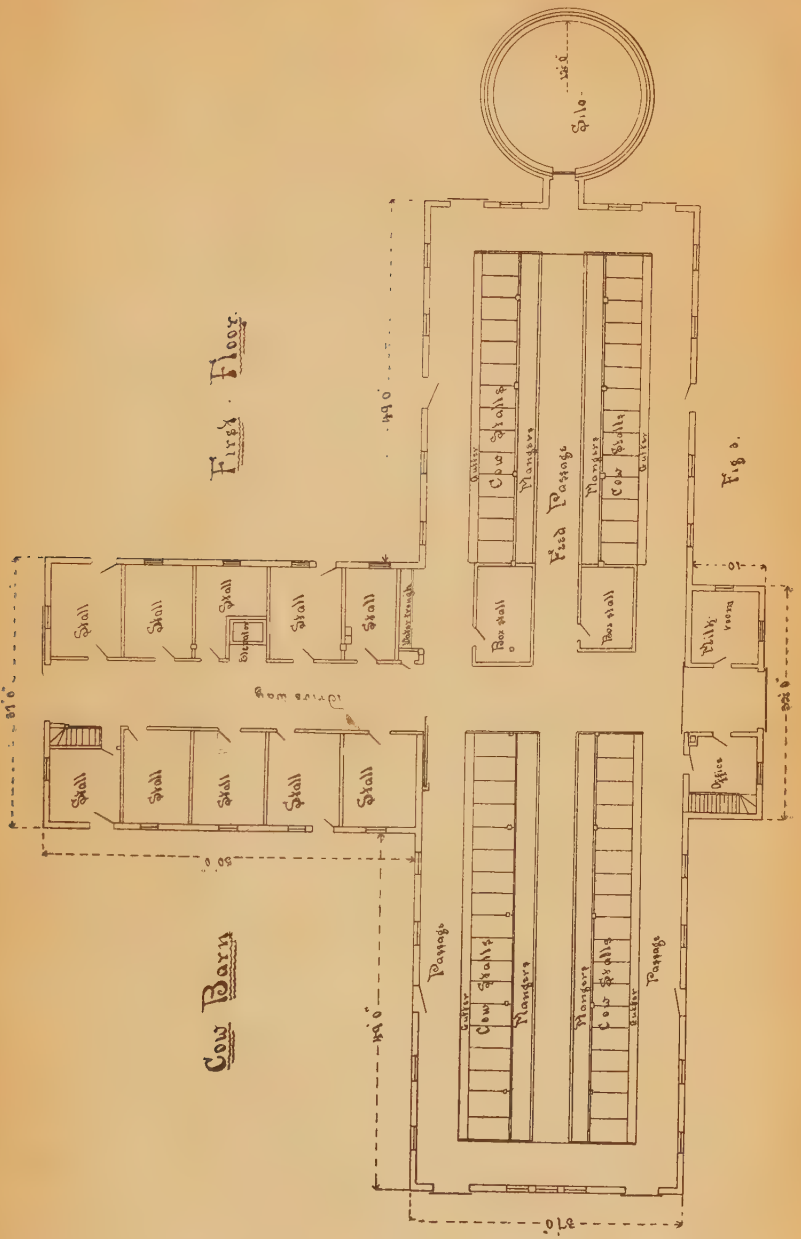
The main part of the cattle barn stands north and south and is 135 feet long and 37 feet wide. It holds two rows of stock facing the center, with a 5 foot feed passage through the middle. The feed passage connects with the silo, which allows the ensilage to be thrown into a small truck, and drawn through the passage way between the mangers, as it is fed to the stock. (See Diagram 3.)

On the east is a projection 10 feet long by 32 feet wide, con-

CATTLE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

taining an office, a stair footing, and a milk room. On the west is a large wing 50 feet long by 37 feet wide, with two rows of box stalls of different sizes, stairs, watering trough, and closets. The building has 16 foot studding throughout.

Stalls. The stalls are of the Bidwell pattern, and are of different sizes ranging from 3 feet to 3 feet 4 inches in width; and they are 5 and 6 feet in length. The manger is 3 feet wide and 8 inches high, and is movable. It has a fence like portion in the middle which prevents the animal walking forward through it.



PLAN OF FIRST FLOOR OF CATTLE BARN OF THE STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

This stall can be adjusted to suit the size of the animal. The gutters are 16 inches wide and 6 inches deep at the back, with an inch slope from front to back. The box stalls are of different sizes, as shown in the plans.

Second Floor. The second floor has feed bins, attendant's room, and hay mows. The hay is taken in by means of hay forks to all parts of the barn.

The floors of the office and milk rooms are double, with building paper between. These rooms are ceiled with western fir ceiling. The remainder of the first floor is laid with sized 2x10 fir planks. The planks constituting the stall floors are laid with western fir throughout.

The Silo. The silo is round in form and is 24 feet in diameter, inside measurement. The wall is made of brick, 28 feet high and 20 inches thick, with a dead air space in the center of it. The floor and wall are cemented with the best grade of cement. A dormer window in the silo roof serves as an intake for green corn or other material with which the pit is filled. A second dormer window on the opposite side of the roof furnishes light.

E. G. SCHOLLANDER.

THE EDGELEY SUB-STATION.

The last legislative assembly appropriated the sum of two hundred and fifty dollars to be expended upon experiment work at the Edgeley sub-station and the work was inaugurated. The quarter section of land which the citizens of Edgeley and the surrounding community donated to the experiment station for an experiment farm is situated about a mile and a half south of the village of Edgeley and was used for the trial.

The land is undulating and was in reasonably good condition, in the spring of 1901. The larger part of the quarter section has been cropped to grain for several years.

It seemed necessary to fence the portion used for experiment work to scure protection from stock.

A good wire fence was constructed around the twenty acres which lay most uniform and which in every way seemed best suited for comparative trials. The inclosed portion was laid off in one acre plots with suitable passage ways, etc., for easy handling and accurate trimming and measuring of the crops grown.

It is a pleasure to be able to report as much accurate data as the department is able to do for so small an outlay in expenditure. Much credit is due to Hon. B. N. Stone, a member and representative of the board of trustees for his suggestions concerning the trials instituted and for his painstaking and efficient work in making the necessary business arrangements for carrying on the trials.

Mr. James Plott also deserves credit for the accuracy with which he and his sons carried out the details of the work as

planned and for suggestions and information which his experience in the district enabled him to give the writers.

Mr. E. A. Cannon, a student from the agricultural college had immediate charge of the fencing and laying out of the grounds and of the harvesting of the small grain, all of which services were performed in a creditable manner.

The fact that Edgeley is situated over one hundred miles from the central station at Fargo caused a heavy expenditure for car fare and freight, and caused the writers to visit the sub-station no oftener than seemed to be absolutely necessary, as full railroad fare for all transportation constituted one of the heavier items of expenditure. The work begun at Edgeley shows marked results and it is important work for a large district of this state, but if no means is provided for carrying it forward, its value will be limited as results for a single year must always be. The appropriation for the Edgeley sub-station work was for one year only, which leaves no funds for carrying it forward.

A trial which shows a range of from nine to fourteen bushels of wheat per acre for the shallow and deep plowing and that corn land closed the season of 1901 with over 24 per cent of water in the surface three feet, while wheat producing land contained only 10 to 11 per cent of moisture indicates how valuable a study and record of these facts would prove to the people of the farming districts with conditions similar to those represented by the Edgeley sub-station.

The study of the rooting systems of field crops and a trial of forage and grain crops cannot fail to prove of great value to that portion of the state. Trials of rotation methods, drouth resisting grains and sugar beets are important subjects which need investigation for that district of North Dakota.

I would recommend that an annual appropriation of $1,500 be made for the support of the work of the Edgeley sub-station, by the legislative assembly, and I feel that such a sum would bring back many times the amount, in lasting value to that portion of the state.

All of the land in the experimental plots except the east half of plot 16, which is new breaking, consists of old land which has been farmed eight to fifteen years, and quite regularly cropped with grain. The south half of plots 1 to 9 was fall plowed in 1900. The north half of plots 1 to 9 and the whole of plots 10 to 18 were plowed in the spring, before April 28, 1901.

For all crops the fall plowing was prepared with a disc pulverizer, and the spring plowing with a smoothing harrow.

EXPERIMENTS WITH WHEAT.

Plot 3 was sown to Minnesota No. 163 fife wheat, April 30th, at the rate of five pecks of seed per acre. The wheat came up and stooled well making a good stand. The grain was ripe and cut August 5th. The height of the straw was thirty-six inches. The length of the heads two and three-quarter inches. The heads were not well filled and the grain was light and shrunken. The weight of the grain per bushel was fifty-three pounds. Grade No. 3 northern, 90 per cent hard. Yield per acre nine and two-thirds bushels. Inspection clearly showed that the wheat was better on the fall than on the spring plowing.

Plot 5 was sown to experiment station No. 66 fife wheat on April 30th. The west half of this plot was plowed four inches deep and the east half seven inches deep. The wheat made a fair stand on both plots. The grain on each plot was ripe and cut August 7th. The height of the straw was thirty-four inches and the heads were two and one-half inches long. The heads were light and not well filled. The comparative results are shown in the following tabular statement:

Kind of Plowing	Weight Per Bushel—Pounds	Grade	Hard Wheat—Per Cent	Yield Per Acre—Bushels
Deep	55	3 N.	90	9
Shallow	56	3 N.	90	14

The shallow plowing yielded 55 per cent more than the deep plowing.

The east one-half of plot 13 was sown to aronautka macaroni wheat on May 2nd. The drill was set to sow five pecks and two quarts of wheat per acre. This wheat made a good stand and was heading July 5th. It was ripe and cut July 31st. The heads seemed to be well filled, but the grain was badly shrunken. The height of the straw was thirty-nine inches and the length of the heads two and one-half inches. Wheat from this plot weighed fifty-six pounds per bushel. The yield per acre was nine bushels.

The east one-half of plot 15 was sown to experiment station No. 66 wheat on May 2nd. This grain was harrowed with a smoothing harrow as follows: May 20th, May 25th, and May 30th. The result of the experiment was an almost total failure of the crop.

Another plot was sown to No. 66 wheat, May 2nd. This grain was harrowed three times as follows: May 20th, May

28th, and June 6th. The result of the experiment was an entire failure of crop..

*EMMER.

The east one-half of plot 13 was sown to emmer, usually called spelt, on May 2nd. The drill was set to sow eleven pecks of barley per acre. This sowed about two bushels of emmer per acre. The grain made a good stand. It was ripe and cut July 31st. The length of the straw was twenty-eight inches and the heads were two and one-half inches long. The heads were plump and well filled, and the grain weighed twenty-eight pounds per bushel and produced eighteen bushels of grain per acre.

OATS.

The alley around the outer edges of the plots was sown to oats. On August 6th, it was noted that the oats had made an excellent stand and were well headed and filled, representing at that date the best appearing and most profitable crop on the grounds. The oat crop in the Edgeley district was generally good last season.

FLAX.

A small plot (.45 of an acre) of spring breaking was sown to flax May 17th. The sod was disced four times and harrowed twice and was in good condition when sown. The flax was seeded with the drill at the rate of twenty quarts per acre. It came up well and made a fair stand and a good growth. The straw stood twenty-six inches high August 8th. The seed yielded at the rate of 6.6 bushels per acre, and weighed fifty-two pounds per bushel. The seed was of good quality.

Plot 4 (old land) was sown to flax May 10th. The flax made a very poor stand on this ground. No yield was taken, but it was observed that the crop was considerably better upon the spring than it was on the fall plowed land.

CORN AND FORAGE CROPS.

Plot 9 was planted to corn May 3rd. In this trial North Dakota No. 100 seed corn was used. The corn was sown with a grain drill; the east half of the plot was seeded in drills fourteen inches apart and the west half in drills thirty-five inches apart. The drill was set to sow three and one-half bushels of oats per acre. This corn was harrowed May 18th, May 25th, and June 6th. The east half of the plot was cultivated June 7th; the west half, July 10th. The corn was badly injured by frost on June 7th. On August 8th the following facts were noted by field inspection. The corn planted in thirty-five-inch drills was about

* Commonly called spelt.

one-half of a stand, and was quite weedy, probably owing to a lack of cultivation. The stalks were about four feet high and the corn was in full tassel and silking. The corn planted in fourteen-inch drills was about one-fourth of a stand, three and one-half feet high and weedy. It was in the silking stage at that date. The yield of fodder from these plots was not taken.

Plot 18 was sowed to corn May 10th. The west half in drills fourteen inches apart and the east half in drills thirty-five inches apart. The drill was set to sow three and one-half bushels of oats per acre. The corn on this plot seemed to be less injured by frost than it was upon the other plots. On August 8th the stand was noted as "fair." The corn was in tassel and stood four feet high in the thirty-five-inch drills and three and one-half feet high in the fourteen-inch drills. Upon that date the soil was mellow and in a fair condition as to moisture as shown by the moisture determinations. (See accompanying tables.) This corn was cultivated as follows: Harrowed May 25th, June 6th and June 21st. The east half was cultivated June 27th. The cultivation had not been sufficient to keep down the weeds. Mr. Plott reports the yield from the whole plot as three tons of fodder per acre.

Plots 6 and 8 were planted to North Dakota No. 100 corn May 10th. The corn came up well but was nearly all killed by the late frost of June 7th. The plot was seeded to German millet about June 15th. On August 6th the millet stood fifteen inches high and was a good stand. It yielded one and one-half tons of hay per acre.

Plot 10 was planted to Mercer corn and kaffir corn on May 9th. The corn was almost entirely killed by frost on June 7th, and the plot was sown to millet.

The west half of plot 12 was sown to yellow Canadian field peas. The peas were beginning to blossom June 26th, and were cut for fodder July 29th. The length of the vines was about two feet. The stand was poor and the yield was not taken.

Plot 14 was seeded to Japanese barnyard grass on May 2nd. drill was set to sow three pecks of flax per acre. On August 8th the grass stood twenty-four to thirty inches high, and was a fair stand. The leaves were wilting and brown at that date, and the crop seemed to be suffering badly from drouth. There was a considerable bottom growth of Russian cactus on this plot. Mr. Plott reported the yield as two-thirds of a ton of fodder per acre.

SEEDING TO GRASS.

The east half of plot 12 was seeded to timothy without a nurse crop. The weeds were mowed twice during the season. On August 8th no timothy could be observed, but there was a heavy growth of cactus on the plot.

Plot 1 was seeded with Austrian brome grass April 30th, at the rate of fourteen to sixteen pounds to the acre, and without a nurse crop. The ground was prepared thoroughly. The fall plowing was disced and the spring plowing was harrowed to make a good seed bed. The seeding was done with a Monitor shoe drill. The weeds were mowed twice during the season. On August 6th it was noted that the plot was weedy, and that the brome grass was thin on the ground, and had made a slender growth. A few spears were noticed, three to four inches high at this date.

The east half of plot 2 was seeded to Turkestan alfalfa, sown with the drill which was set to sow flax at the rate of ten quarts per acre.The ground had been prepared as already noted for the seeding of Austrian brome grass. The weeds were mowed twice on this plot during the season. On August 6th it was noted that the alfalfa had made a very poor stand. Some plants were found which were two to four inches in height. The ground was covered with a thick growth of Russian cactus.

RAPE.

On May 4th the west half of plot 15 was sown to dwarf essex rape in drills thirty-five inches apart. The drill was set to sow two pecks of flax per acre. On August 6th the rape stood about thirty inches high and the plants were large and leafy. The rape made about one-half of a stand. It seems probable that with good cultivation this plant will make a profitable annual pasturing crop for the Edgeley district.

REPORTS UPON POTATOES, SUGAR BEETS AND ARTICHOKES.

Plot 11 was planted to potatoes of several varieties, to sugar beets and to early French artichokes.

The artichokes did not mature and were killed by frost September 18th. The tubers had developed to about the size of hens eggs.

The potatoes were a poor stand.The early varieties, such as the Early Ohio, Early Dawn and Six Weeks yielded best. The Rural New Yorker No. 2, a medium late variety,also proved to be a good producer. Experiments in treating potatoes for scab wth Formaldehyde solution were a practical failure on account of the poor stand.

The sugar beets made about one-half stand. Two samples

were analyzed by Prof. Ladd of this station. The samples were taken on September 28th. His report is as follows:

Variety	Average Weight—Pounds	Per Cent Sucrose	Co-efficient of Purity—Per Cent
Number 5770	1.3	13.32	83
Number 5772	.7	10.52	60

Prof. Ladd describes the beets as not quite ripe.

Mr. Plott estimated the yield at from eight to twelve tons per acre.

SOIL MOISTURE STUDY.

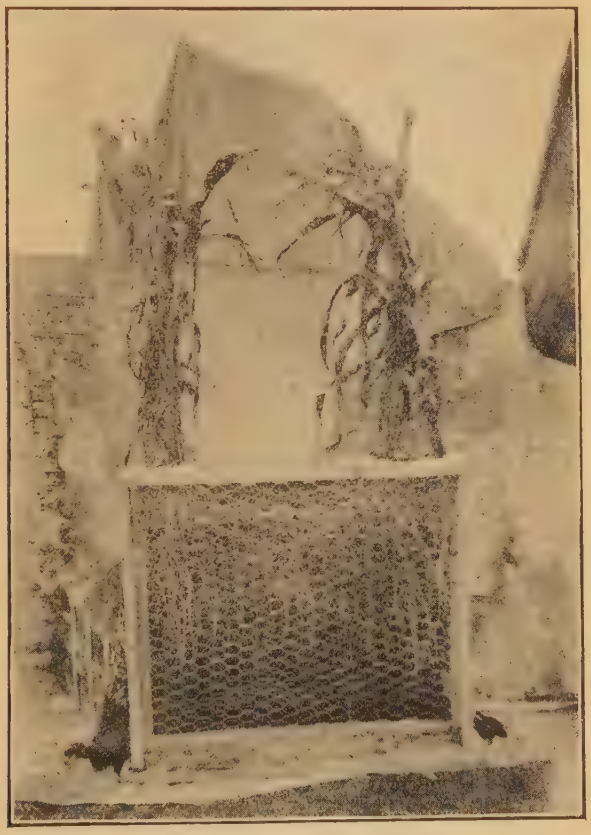
Samples of soil were taken from several of the experimental plots soon after seeding time, May 8th, and moisture determinations were made. The percentages of moisture found in the soil at that date are given in the following table:

Plot No.	Treatment or Crop	Percentage of Moisture			
		1 to 6 Inches	1st Foot	2nd Foot	Average
7	Manured, spring plowed 4 inches deep, left fallow	28.1	25.4	20.7	23.0
9	Spring plowed, 4 inches deep, planted to corn	21.0	21.7	22.5	22.1
5 S—½	Fall plowed, 4 inches deep, sown to wheat	25.6	22.9	15.0	19 0
5 N—½	Spring plowed, 4 inches deep, sown to wheat	23.4	24.1	18.1	21.1
16	Sod not plowed	19.6	22.2	22.9	22.5

It will be observed that there was not a great difference in the moisture content of the soil at seeding time. At about harvest time, at the date the root samples were taken (August 8th) samples of soil for moisture determination were again taken from the several plots which are described in the above table, and which were being cropped with different crops. The percentages of moisture found in the soil of the several plots at the different depths at that date are given in the following table:

Plot No.	Treatment or Crop	Percentage of Moisture			
		1st Foot	2nd Foot	3rd Foot	Average
7	Summer fallow, spring plowed, plowed second time July 25	22.8	26.4	24.0	24.4
9	Corn cultivated	17.1	27.5	38.0	24.2
5 S—½	Wheat stubble, fall plowed in 1900	11.8	9.3	9.4	10.2
5 N—½	Wheat stubble, spring plowed in 1901	10.3	7.4	15.8	11.2
16	Flax on spring breaking	10.9	28.4	25.0	21.4

It will be observed that the largest percentage of moisture was conserved in the summer fallowed land. There was almost as large a percentage of moisture in the corn land as in the summer fallowed land. The surface foot of the corn land was comparatively dry, which was due to the fact that the corn had not been cultivated properly, and there was a considerable growth of weeds which exhausted the water in the surface soil. However, as will be noticed from the table large amounts of water had been conserved in the corn land in the second and third feet. The wheat land is the dryest in each case. The difference in the moisture content of the wheat land and the corn land amounts to about 14 per cent on the average for the three feet of soil.



CORN ROOTS TAKEN AT THE EDGELEY SUB-EXPERIMENT STATION.

A ROOT STUDY AT THE EDGELEY SUB-STATION.

On August 6th to 9th samples of wheat and corn roots were taken at the Edgeley sub-station farm, by the method which has been employed at the central station at Fargo, which is described in Bulletins No. 36 and 43. Figures 6 and 7 are photo-engravings of these samples.

NOTE—The half-tone engraving, representing the specimen of wheat roots taken at the Edgeley Sub-station, was accidentally destroyed at a time too late to permit of another cut being made in time for it to appear in this report.

The sample of wheat roots is not especially good; the wheat was too ripe and the roots were dead, and brittle, and easily washed away by the spray from the force pump. By very careful work, the roots were secured to a depth of three and one-half feet. This seemed to be about as deep as the roots were able to penetrate at the spot where the sample was taken, on account of a layer of shale which appears in the soil at that depth.

At Fargo the roots of wheat have been found to penetrate four to five feet deep.

The sample of corn roots is a very good one and shows the distribution of the roots between two hills, three and one-half feet apart. Some of the roots were five feet long, extending from hill to hill, and two to three feet deep into the soil. The sample shows the growth of roots which had taken place in eighty days. The roots had not yet reached the layer of shale. Some of the vertical roots, however, had reached the depth of nearly three and a half feet. It was observed that the soil of the corn field was much more moist than that of the wheat field. Corn acts as a conserver of soil moisture, and it also leaves a large mass of roots in the soil, which readily decay and supply the food of succeeding wheat crops. At the Fargo station corn has been found to be one of the most valuable rotation crops. For a comparison of the moisture of the soil of different plots, see accompanying tables.

A. M. TEN EYCK.

ACKNOWLEDGMENTS.

During the past year A. M. Ten Eyck, M. S. has assisted me in conducting the experiment work carried on by the department. The greater portion of the work of the department has been carried jointly, while he has become individually responsible for certain portions of it, as will be seen by this report and by other published matter.

Mr. E. G. Schollander rendered efficient aid to this department in the early part of the season by acting as student assistant and later as an assistant on full time. His work has been chiefly in seed breeding, seed selection and in seed distribution. He has

also largely relieved the department from work in farmers' institute meetings by filling a position upon the farmers' institute staff of speakers.

Mr. H. M. Ash has acted as farm foreman during the past season and has become responsible for a large portion of the detail work carried by the department.

Mr. L. F. Seneco has rendered creditable service in field plot and soil work and in preparing and placing exhibits for the station.

My thanks are due Prof. E. S. Keene of the mechanical department of the college for aiding this division by taking photographs, arranging for illustrative cuts, preparing lantern slides and stereoptican apparatus and for aid and suggestion relative to various illustrative material.

Hon. B. N. Stone of Edgeley, a member of the board of trustees aided the department materially in the work at the Edgeley sub-experiment station, as is noted in the body of this report.

J. H. SHEPPERD.

DEPARTMENT OF HORTICULTURE.

To Director J. H. Worst:

Sir: The work of the horticultural department for the year 1901 was along general lines of tree, fruit and vegetable culture. Because of the new conditions existing in the state, particularly as pertains to horticulture, the demand is for demonstration work of a general nature and the building up of improved varieties, rather then for experimentation along special lines. Up to the present time there has been almost no variation from the constantly repeated question "what shall I grow and how shall I grow it?"

It has been the aim of the department to furnish a perpetual reply to the question through its garden and fruit and tree plantations.

About four acres are devoted to the cultivation of vegetables, particular attention being given to onions, celery, cabbage and those other sorts having a considerable market value, and requiring for their profitable production particular methods of cultivation.

The large number of visitors coming to the station each year with the farmer's excursions makes this feature of the work of the department not only a useful, but practically a necessary one.

Owing to the excessive rains of the past season about half of the vegetables were drowned out, and most of the others suffered considerably. In spite of that a creditable showing was made

with cabbage, onions, celery and corn, specimens of these securing premiums over others of their class when exhibited at the Pan-American exposition at Buffalo.

The fruits made a fair showing in yield, and all made a good season's growth. Several apple and plum trees were added to the orchard and forty additional varieties of strawberries were added to the trial beds.

The injury that the bearing beds of strawberries received in May from the severe winds that extended over a period of about three days, showed the necessity of providing protection for small fruits and the tenderer plants.

With this necessity in mind considerable attention has been given to hedges and shelter belts, and the results obtained have created much interest. The hedges proved to be one of the attractive features to the many hundreds of visitors at the station grounds during the past season. The Russian Golden Willow, Buffalo berry, Caragana, Russian Wild Olive, soft maple and wild plum are among the best hedge plants, the Russian willow making the most rapid growth, and being the best for strictly shelter purposes. It is also very attractive when cut to a low hedge, while the bright golden red color of its twigs makes it quite as pleasing in winter as in summer. Several thousand cuttings of this species were sent out last season, and arrangements have been made to continue the distribution in 1902.

The year 1901 demonstrated very clearly the superiority of the Carolina poplar as compared with the cottonwood, which it resembles. The cottonwood is subject to a leaf rust, which in warm wet seasons becomes so bad as to defoliate the trees early in the season. This rust will not grow on the Carolina poplar, which remains green and healthy after the cottonwood has lost all its foliage.

The Russian poplar, (P. centinensis) which has been favorably mentioned in previous reports, also holds its foliage until very late and seems in every way superior to the cottonwood.

ENTOMOLOGY.

In the latter part of May reports of grasshopper ravages began coming to the station. These reports were from widely separated points, but at no one place was the infested area large enough for extended damage to occur. By means of previous reports, bulletins, correspondence, and particularly personal visits the habits of the grasshopper and the proper means of its destruction were matters of pretty general knowledge and whenever it was considered necessary steps were taken to prevent damage.

A visit to the different points, in July and August showed that in many places the migratory locusts had left before depositing their eggs, while at other points, particularly in eastern Barnes,

western Cass and southern Steele counties eggs were being laid in fields here and there.

The attention of the owners was called to the fact, and nearly all declared their intention of plowing the land before the time of hatching of the eggs. In spite of this intention some fields will doubtless be left, but if they are plowed as soon as the insects are found to be hatching, no great harm can result. While the situation is not alarming, it is only the part of good sense to take hold of the matter in good time, and prevent any possible damage.

As has always been observed, whenever the migratory locusts appear the native species become much more numerous, and as many of these breed in the sod, their destruction is not the simple matter as is that of the Rocky Mountain locust. One section of wheat near Fargo was entirely destroyed by these, and many gardens suffered severely, some being totally destroyed.

On a field of cabbages the following remedy was applied with complete success, when the insects were numerous enough to have eaten everything:

Twenty-five pounds wheat bran.

Two pounds white arsenic.

Three gallons cheap molasses.

Mix the bran and arsenic well before adding the molasses. Then add enough water to wet the whole mixture thoroughly, leaving it stiff enough to be scattered broadcast. This preparation remains moist for a long time, and is greedily eaten by the grasshoppers. It is to be scattered broadcast among the plants, a very light sprinkling being sufficient.

PUBLICATIONS.

In September the department issued bulletin No. 49 which is devoted to fruit culture. It gives in some detail the methods of cultivation found suited to this region, and lists the varieties that have succeeded best. Some of the accompanying cuts are reprints from this bulletin.

Respectfully submitted,

C. B. WALDRON,
Horticulturist.

DEPARTMENT OF VETERINARY

To President J. H. Worst :

Sir: Since making my last report some much needed improvements have been made in this department. I am now occupying four rooms divided into museum, class room and laboratory, all in Francis hall. The office is a well lighted and heated room, and is supplied with library of all the latest books relating to the study of veterinary science. The museum is nicely situated and supplied with tables and cases for the preserving of specimens which I am preparing. The class room is a pleasant room for class work. The laboratory is well lighted and heated and fairly well ventilated. This room is used for the advanced class for dissecting specimens, which are afterwards used before the lecture class and then returned to the museum where they are retained as specimens.

The work in this department has been mostly educational. The winter term of 1901 had seventy-one pupils enrolled. They were taught by lecture how to successfully care for the different domestic animals. The enrollment in the spring term was five, and the class pursued the study of veterinary anatomy, and physiology text book was introduced for the first term, and the entire three months was given to the study of bones and muscles.

During the fall term there were seventeen students enrolled, taking practically the same course as the spring term students did, and during the winter term of 1901 these students are advancing along the same lines.

The laboratory is used for dissecting different animals. These students now meet in the laboratory one hour each day, five days a week and attend clinics once a week.

The regular winter term has enrolled seventy-four pupils, who meet one hour a day, five days a week, and one afternoon a week for clinics. This class is practically taking the same work as has been given the last two winters. The afternoon clinics have been held in the large operating room in the barn, and at these clinics some of the more common operations were performed and fully demonstrated. The symptoms of disease were pointed out, temperatures of the different animals were taken the catheter was introduced by myself and each student in turn Medicines were compounded, and administered both by mouth and hypodermically, as well as in the trachea, jugular vein, and by every practical and often necessary channel. The aim in the entire class has been to bring the student up to as high a point of efficiency in the care of stock as is possible in the time allotted.

The branches which are taught in this department are anatomy, sanitary medicine and surgery, cattle pathology and obstetrics.

Heretofore this department has been so crowded for room both in the barn and laboratory that no experiments have been undertaken, but now that these objections have been removed, I should like to undertake an investigation of a disease that is quite prevalent in this and other western states, and is spoken of as "pinkeye" in cattle. While the loss from this disease has not been very great, it is extremely annoying to stock owners. The disease is now in the neighborhood of the college, so the investigation could be carried on in the laboratory with specimens from the diseased herds.

I have taken part in seven farmers institutes, and have spoken on the diseases of live stock, their cause and prevention.

Respectfully submitted,

J. W. DUNHAM.

STATEMENT

OF RECEIPTS AND EXPENDITURES FROM JULY 1, 1900, TO JULY 1, 1901.

RECEIPTS.

Received from U. S., Hatch Act, March 2, 1887	$15,000.00

DISBURSEMENTS.

Salaries	$ 5,316.52
Labor	6,931.18
Publications	1,187.58
Postage and stationery	137.90
Freight and express	43.26
Heat, light, water, and power	146.80
Seeds, plants and sundry supplies	252.83
Feeding stuffs	775.61
Tools, implements and machinery	65.32
Traveling expenses	125.00
Contingent expenses	18.00
Total	$15,000.00

C. E. NUGENT,
Secretary.